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FROM FEMALE ENGINEERING CO-OP TO CYBORG ENGINEER: PURPOSEFUL PARTICIPATION WITHIN THE BINARIES OF A COMMUNITY OF PRACTICE

Kirsti M. Arko

Michigan Technological University, karko@mtu.edu

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FROM FEMALE ENGINEERING CO-OP TO CYBORG ENGINEER:
PURPOSEFUL PARTICIPATION WITHIN THE BINARIES OF A
COMMUNITY OF PRACTICE

By

Kirsti M. Arko

A DISSERTATION

Submitted in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

In Rhetoric, Theory and Culture

MICHIGAN TECHNOLOGICAL UNIVERSITY

2017

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This dissertation has been approved in partial fulfillment of the requirements for the Degree of DOCTOR OF PHILOSOPHY in Rhetoric, Theory and Culture.

Department of Humanities

Dissertation Advisor:	<i>Dr. Ann Brady</i>
Committee Member:	<i>Dr. Nancy Grimm</i>
Committee Member:	<i>Dr. Lauren Bowen</i>
Committee Member:	<i>Dr. Linda Ott</i>
Department Chair:	<i>Dr. Ronald Strickland</i>

To my children. May you one day find inspiration from this endeavor –
find your passion and go for it.
I can do all things through Christ who strengthens me. Phil 4:13

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Acknowledgements

so much depends
upon

a red wheel
barrow

glazed with rain
water

beside the white
chickens.

William Carlos Williams

No earthly being could have ever known that it would be these eight short lines that stoked my intense love for language and the power that is possible with each and every word. And in this journey, it has been words, whether spoken, read, or written, that have been the joy which has delivered me to this place I now inhabit. Really no different, just a journey that included many many words.

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And whatever you do, whether in word or deed, do it all in the name of the Lord Jesus, giving thanks to God the Father through him. Colossians 3:17

Abstract

In order to fill the current employment gaps in STEM, specifically engineering, initiatives have shifted towards increasing the number of women and minorities, who are both significantly underrepresented. (National Science Board, 2016) If cooperative education is to participate in this, we must first ensure the unique qualities of the women's co-op experience are adequately understood for practitioners to assist in setting the women up for success and best meeting their needs. Cooperative education research on female co-ops is limited, thus missing out on an opportunity to assist in these national initiatives. This dissertation provides a study on female engineering co-op students and their experiences as women in a male-dominated profession. The framework on which this dissertation rests encompasses four key feminist theorists: Simone de Beauvoir, Sandra Harding, Donna Haraway, and Kathy Charmaz. Harding (1991) calls for a shift in the sciences to be more inclusive of women, and a valuable approach in this research is to think from the women's perspectives. The women's voices were critical to this study, so the qualitative data consisted of two rounds of in-depth interviews to gain their insider perspective into the everyday realities of their co-op experiences. Utilizing Wenger's (1991) social theory of learning, I argue that the experiences associated with the community of practice are most significant, because it focuses on the learning beyond mere skills. Through an analysis on the culmination of the women's perspectives, I offer a theoretical model that identifies the key areas of negotiation the women faced within their communities of practice; those key areas being gender, identity, and learning. Ultimately, the model I propose, based on Haraway's (1991) cyborg metaphor, provides an approach to cooperative education which focuses on the negotiation required within a community of practice, the choices that are available within the community, and the social change the women can potentially generate, ultimately shifting their communities to be more inclusive of those populations they are working to garner.

Moving Across Campus and Communities: An Introduction

For me, I need work that is meaningful, work that makes a difference, and work that has a bigger purpose than just me. Throughout my career, I have been in positions where I can see the difference my work makes for others' education, and that is what brings me joy and fulfillment. As an Assistant Director in the Michigan Tech Multiliteracies Department (MTMC), I found joy and fulfillment in every day of my work. I had the opportunity to see the ultimate potential in education when we shift our perspective for a chance to learn something about ourselves, to give something to others, and to make a difference for everyone. Those within the center were part of a place with goals much bigger than what outsiders would expect. We were there with a purpose: "To function as agents of change in higher education, to work toward a fair practice, writing center workers must understand how systems function, how language influences the construction of Self and Other, how literacy works as cultural and social practice, how political action produces social change" (Grimm, 1999, p. 110). The MTMC was a place where students, faculty, and staff from the university could come for an appointment to work with a coach on writing or other communication. (Coach was the term used for the "tutors," who were Michigan Tech undergraduate and graduate students.) For the MTMC users (mostly students), it was a time to have a conversation about an assignment, school, or life. There was a depth and richness to these conversations, the types of conversations that are not

always easy and definitely rare on campus. The issues were bigger than the assignment, as they incorporated a student's story, history, and culture. For the coaches, their jobs were more than the assignment as well. Their job included an educational component and opportunities to serve as agents of change. The coaches participated in a for-credit course, and then an ongoing weekly meeting where the training continued and the conversations included topics much deeper than grammar. There were conversations of identity, negotiation, and social justice based on literacy and writing center theorists like Harry Denny, James Paul Gee, Nancy Grimm, and the New London Group. Just to be a part of this tiny corner of campus where students were gaining an education far beyond their academics was truly a gift and showed me the potential for a model of education that could make a significant difference in the coaches' lives and their impact when they leave campus.

I would go to work with a feeling of exhilaration, not knowing the conversations I would have nor the stories I would hear. This was truly a special place and one in which I believed was replicable outside of a university writing center setting. This was a model that I wanted to share with other units of the university. Michigan Technological University is a highly respected STEM school, and the MTMC was a unique corner of the university where the educational gains were not present in other parts of the curriculum. The coaches' transformation was so great I believed there was a

way to expand this type of education so other engineers would leave with a new perspective and the experiences necessary to understand larger social issues and ultimately make a difference in their workplaces and communities. When I left the MTMC for Career Services, I believed I could take this model with me.

Until my Career Services work began, I didn't realize the significant difference there would be in the types of conversations I would have with students in this new context. While there was some consistency considering they were still Michigan Tech students, it was a different world and one in which those deep conversations were silenced. While it was partially the context and timing of the work, there was also no catalyst to encourage these types of conversations nor topics beyond a resume, interview, or other job related questions. In my new role, I even had the opportunity to bring my experience with learning center coach training as I was given the responsibility of Career Learning Center staff management and training, but even here it stayed superficial, light, and career-focused. This was not the model I was accustomed to and the most meaningful part of my work was missing. Surely, there must be more to this place called career services. How can students from the same university be so different? Wenger (1991) was a key theorist in the MTMC model, and his theory of social learning within a community of practice provided the explanation as to why the model worked.

As I began to figure out my new community, the community of practice was a key feature that was missing for the students in career services. The MTMC model was clearly a community, and the members' transformations came as a result of their learning and the shifts in identity that were a result of their learning. The MTMC was a place where Wenger's theory was alive and well.

The conversations I would have with students in career services were very different, but not only that, I was finding limited potential for meaningful conversations or long-term relationships. While I attempted to shift the coach meetings to more a collaborative setting, the content was still superficial. In my advising, day after day I would speak with students about getting a job, negotiating their salary, or describing their class project on a resume. The model of education on this end of campus was to get a job and ultimately, a paycheck. Not only was this the model, but underneath was an urgency and drive for the students to secure a position that was worthy of their last four-plus years of hard work. And that urgency was underlying our work with the students because the university administration, and even the state, focuses so heavily on placement rates. Our students must get jobs. At Michigan Tech, our placement rate is actually very successful (94+%) and nearly all of our students do not struggle finding work in their field, but that did not eliminate this ongoing stress for them and us. We must do more, do it bigger, and do it best. Is this what education had come to?

In addition to overseeing the learning center and advising, my most significant role in career services was the university co-op program. Ultimately, within career services our co-op curriculum was not focused on technical projects and skills, because we knew their worksites and supervisors would ensure they were technically sufficient, and we were unqualified to do so. Rather, what we were capable of and what was equally important was to ensure these students were not overlooking all of the other skills and knowledge they were gaining as a result of their co-op experience. And the primary way we were to do this was through online discussion and personal reflection. I knew reflection and I knew it well. This was one of the most significant methods we had used with our coaches in the MTMC. If the co-op students would just reflect, they too would see this experience as something more than work experience. Even co-op research had included this as a valid pedagogical method which lead to the desired outcomes. (Harvey, Coulson, Mackaway, & Winchester-Seeto, 2010) With reflection, there was no way they could leave as the same person in which they began. After two semesters, I even reconfigured the entire educational co-op program to better serve the students and more successfully aid in their transformation during cooperative education. Once it was all in place, the fall 2015 semester began... but my expectations were not met. The deep reflection and transformations were not happening. Instead, I would read

course evaluations that questioned the need for the co-op course, or a complaint on the amount of time used to complete the course assignments, as their preference would rather have been to put that time into focusing on their real work. And while this attitude was not held by every student, there was enough feedback to let me know that my dreams had died. This co-op course was not going to create future engineers and other STEM professionals who would enter their workplaces with a keen sense of the underlying systems and social issues complimented by strategies in which to make a difference in their communities. Instead, these were now students with work experience who were more technically prepared for their next position and had gained a better understanding of the workplace expectations. This was not an ultimate fail, as most career services professionals, even university departments, would consider this successful and the true reason for cooperative education. (Wilson & Lyons, 1961) These students are now better prepared in many ways, technically, professionally, and even in terms of understanding their career path. But having witnessed the MTMC outcomes, I could not be satisfied knowing there was the potential for something bigger. Once I had recognized how learning occurs in a community of practice and the potential for transforming selves and communities, I wanted to replicate that type of learning for other students. "We all have our own theories and ways of understanding the world, and our communities of practice are places where we develop, negotiate, and share

them” (Wenger, 1991, p. 48). I was wanting to provide another community of practice for these students in order that they would have access to a unique way of understanding the world.

Being we had met the traditional co-op objectives, I could not be completely dissatisfied with the results, but I had to compare the factors between the two groups of students to understand what was missing for the co-op group.

First, being they were all enrolled in a required course, they may have not signed up willingly, rather they were required to enroll in the for-credit course.

With that, the course then had requirements they were forced to participate in, such as reflection assignments and group discussions. In the MTMC,

these students had been hired, meaning they were interested in the type of work and they chose to enter that community. Even during the coach

interview process we asked questions and tried to provide evidence as to the kind of community it was and how we approached the educational

component. The co-op students did not have this choice. They needed the

job, thus the course came with it. Also, the group was large, 150 students on average, whereas the coaching staff was typically 25. The population of

students was also problematic because these co-op courses were available to both undergraduate and graduate students. The graduate students were

mostly international students on campus, with the highest percentage

working on their Master’s Degree. For them, their studies were high-stakes

and career focused. Some of them had returned to school after already working in industry, so they came with professional experience. Most had also come from an educational system that was very different from the U.S. education model I was accustomed to. Having studied in English Education, I was well versed in critical thinking and reflection, but I was asking adults to participate in an educational method that was completely foreign to them. In their undergraduate studies, the entire system revolved around tests, not writing about how their experiences affected them. This was not something they were not accustomed to nor was it a priority at this point in their lives.

Being this course was in session while the students were working, the course was also done entirely online, with the exception of a mandatory co-op meeting that took place prior to the start of the semester. So other than meeting me briefly or attending the meeting, I did not have a relationship with these students, nor did they with each other. In the MTMC, the relationships between coaches, myself and the coaches, and the coaches and their students were critical to the conversations and the opportunities for reflection, which made for a diverse group who were united by their willingness to consider viewing the world with an alternative lens. Without relationships there is no trust, and without trust no one is going to have the difficult conversations nor engage in discussions that may be deep or uncomfortable. There were no consistencies in the co-op students' lens like

that of the MTMC. Ultimately, there was not a community amongst the 150 students who were enrolled in co-op, and one online course asking them to participate once per week was not enough to create any type of true community. In the MTMC, I was continuously engaged in conversations with the coaches, even if they seemed insignificant at the time. But it was the culmination of all of those conversations and our common lens that created the relationships and built the community. These differences were so significant that it became clear why I could not recreate what I had come to love in the MTMC. Their community of practice was not with each other in these co-op courses, rather their communities were their worksites, of which I was not a member nor did I have access to understand these communities. This changed everything, because I no longer belonged to the same community as I had with the coaches in the MTMC, thus I had no access and very little insight. In my previous role, I had a stake and I had the access to help shape that community, but now these communities belonged to the students. As an outsider, I had to figure out what I could do to assist co-op students in their own communities of practice.

As I began to question what cooperative education could do, there was an even bigger question that had to be answered - what did the students need? I did not know to what degree the students were aware of their learning in a community of practice. When I began this study, I wanted to learn more

about the Michigan Tech students who participated in cooperative education to better understand the type of learning that occurred, how it happened, and then which ways it was beneficial to the student after the co-op experience. And in my quest to recreate the MTMC model, I wanted to determine the opportunities and potential limits of cooperative education.

In this journey, I turned to the cooperative education's history and research, which I quickly realized was significant considering its 100-plus year history. The co-op history provided important foundational information regarding its roots, its earliest publications and theorists, and how cooperative education had been defined, including its policies and procedures. Regardless of the topic, history is always a crucial component in understanding the present and future, and co-op was no exception. As I reviewed the research that had been done, each decade produced new directions for the research with a developing depth and sophistication to the themes and methods, especially since 2000. But considering my own population of students, there was little to read regarding gender and co-op, especially female engineering co-ops. This gap became evident quite quickly, even stretching my research to include a search in the engineering and engineering education journals. While the topic of women in engineering was currently popular, cooperative education and female engineers was left with very little. After finding this gap in the research, there were clearer objectives for my research to include better

understanding the co-op experience for women and the potential in contributing to the recruitment and retention of women in engineering.

Having narrowed part of the focus on women in engineering, a feminist framework provided the tools that had the highest probability in discovering something different than cooperative education had done before. This method was relatively unique to this field, yet one that could provide a new perspective and outcomes. While previous gender/co-op studies had found limited significance in the experiences for men versus women (Rowe, 1980), I anticipated a feminist approach to bring forward those details that had been previously overlooked. Considering this, I focused the design on Charmaz's (2014) grounded theory. This method allowed the research to open up new opportunities and new directions that I would not have been aware of prior to analyzing the data and questioning what I was finding. "We construct our grounded theories through our past and present involvements and interactions with people, perspectives, and research practices" (Charmaz, 2014, p. 17). Throughout this research, I was constantly constructing and reconstructing, with the freedom to do so and the flexibility to ensure I was not constricting my view and missing out. In addition to flexibility and a keen awareness of allowing the data to shape the routes and theories, Charmaz understood some of what could only come through a qualitative study. "Rich data are detailed, focused, and full. They reveal participants' views, feelings,

intentions, and actions as well as the contexts and structures of their lives” (p. 23) These details (views, feeling, intentions, and actions) would provide an insider perspective into the experiences of women in cooperative education.

Haraway (1991) also inspired my search to find and see something different. This led to an awakening of the dichotomies that were appearing throughout my research and the key pieces of the co-op experience.

- Gender: male/masculine v. female/feminine
- Identity: student v. professional
- Learning: skill v. knowledge
- Research: quantitative v. qualitative

Her cyborg argument erases these lines, rather encouraging the need for both and relieving the necessity of choosing sides. The tension should not be in choosing, but rather moving into a place that eliminates the dualism and instead looks to an alternative: the cyborg.

Cyborg writing is about the power to survive, not on the basis of original innocence, but on the basis of seizing the tools to mark the world that marked them as other. The tools are often stories, retold stories, versions that reverse and displace the hierarchical dualisms of naturalized identities....Feminist cyborg stories have the task of

recoding communication and intelligence to subvert command and control (p. 175).

Through the qualitative portion of my research, I could subvert command and control in giving the women an opportunity to tell their side of the story. And though I gave voice to women, I did not need to rest on gender alone. When these women participated in their communities, it was complex and challenging. Previous research had downplayed the difference in cooperative education experiences for men versus women, making the experience seem similar regardless of gender. Considering the complexities of entering new communities, I knew that the results may not be accurate for all women, especially the engineers I was working with, because the negotiations and challenges of entering a new community in which they were a minority could be even more complicated. The women needed a platform from which to speak, and I needed to listen. And this listening had to be without preconceived notions, hopes of what I was hoping to hear, nor pushing my own agenda in their responses. I just wanted the women to talk. The focus on the women in the co-op cohort proved useful not only in the richness of their insights, but also in giving a voice to an underrepresented population in co-op research. I desperately wanted to give these women a voice and an opportunity to share their experiences on life as a female engineer in a co-op position.

When the women told their stories, it then seemed plausible that I had been correct in predicting the qualitative data would provide insight into the realities of their workplaces. These insights would allow myself and others in the field to know what good practitioners want to know, as I had learned from Harding (1991). When she argued for a feminist science that brought in perspectives that were otherwise absent, it was merely to make it better: “In short, feminist theory can help scientists learn all the things good scientists want to know” (p. 74). As a good co-op practitioner, there was more I knew I needed to know. The women’s voices allowed me to better understand the challenges and victories in their projects, the relationships they formed with those around them and the significance of those relationships to their work, and their own growing confidence and shifting identities that came as a result of their experience. When I combined the quantitative data and the qualitative data, they complimented one another. The numbers provided a numerical base, but the qualitative data examined the stories behind the numbers. The women enriched the data by complicating the results and giving insights into the related nuances that were not clear in the numbers. Through the analysis, the aforementioned binaries were exposed as I worked through the complexities of gender, learning, and identities. There was clarity in understanding what these women experienced, but also how their co-op learning was closely tied to their confidence and identities. Their stories made clear what I needed to do with this research - if I could provide a model

that represented a holistic view of the learning experience for female engineers, it would allow myself and other co-op practitioners to better respond through our co-op programs and curriculums.

Considering the realities for women in engineering who participate in cooperative education, do we as co-op practitioners have a role in preparing them for those realities? If I were to prepare these women, I see a curriculum that encourages them to participate as members conscious of their communities and their choices rather than passive participants who leave their circumstances out of their control and rather up to chance. With the awareness and strategies that I see equipping them with, we are then preparing them to recognize opportunities and operate as agents of change. Thus not only making a difference for themselves but also those around them. With their active role, the male-dominated communities may then begin to shift so there is a greater awareness of the underlying stereotypes and discriminatory practices that are at play, which ultimately are a detriment to everyone. Being these women are historically the minority in these communities, their outside perspective provides a view and a chance to disrupt that which has been normalized and they can begin to make strange that which had been considered the norm, having had very few women present to ever question those normalized practices. Considering the potential of these women, we should recognize the role a co-op plays in the

participants' identities and the significance this has on both the present and future. Knowing this, I plan to scrutinize our own co-op curriculum to evaluate its effectiveness, especially for those populations who may have significant challenges. With this research, I am confident I will be able to provide a better product to those who are enrolled in cooperative education, and even bigger, this will provide other co-op practitioners an opportunity to look at their students and critically assess whether there are needs left unmet and opportunities to do more.

Chapter 2: (Literature Review) Co-op Comes Full Circle: Returning the Research to Engineering, from the Women's' Perspective.

In chapter 2, I have provided the historical foundation of cooperative education in order to track its development, the research themes and threads, and ultimately the gaps that are left unfilled. I then posture how this study will answer the research calls in the field, including the population and the methods.

Chapter 3: (Methods) The Marriage of Cooperative Education and Feminism: Uncovering a Fresh Perspective.

In chapter 3, I provide an argument as to why cooperative education needs a feminist approach to offer something new to the research. In addition, I am careful to explain the feminist framework from which I will work, the advantage of feminist standpoint theory in providing a voice to those who had

been historically silent, and the freedom in grounded theory so as not to be limited with where the data may lead, but the potential to follow the data without pre-constructed direction.

Chapter 4: (Results) Key Insights into the Co-op Experience for Female Engineers: Focusing on Self-Efficacy, Gender, and Identity Outcomes.

Chapter 4 presents the results of the quantitative surveys regarding the students' changes in self-efficacy within the three areas: academic, work, and career. The qualitative data is also included in those sections, offering an explanation for the numerical results. Using the results of the interviews, there are other key themes that help us to better understand the co-op experience for women in engineering, both in terms of their learning and the impact it has on their identities, especially as women.

Chapter 5: (Discussion) An Efficacious Space in a Community of Practice: Aligning as a Cyborg Engineer .

After identifying the results, chapter 5 then goes into a discussion on the implications of those results. First, there is a detailed explanation of skills and knowledge in order to identify what the women learned in their co-op.

Knowledge then is the link between cooperative education and Wenger's social theory for learning in a community of practice. While skills have been adequately researched in co-op research, knowledge has not, and more important is how the social theory of learning and the knowledge gained is so closely connected to identity. Thus, a cooperative education experience may

provide greater confidence in an array of skills, but the participant's identity is also an important outcome of this method for learning. Knowing the intricacies of how gender, identity, and learning are functioning in a community of practice, I then offer a theoretical model as a response to the binaries within the community, and a space from which to work within the community that eliminates the need to choose sides. This chapter concludes with a recommendation for future work that builds on this research.

Co-op Comes Full Circle: Returning the Research to Engineering, from the Women's Perspective

As a co-op practitioner, I am forced to make programmatic decisions everyday which ultimately affect the students participating in the program. Prior to this study, my decisions were based on institutional history and established practices, but I often questioned those decisions. While institutional history is valuable, cooperative education has a much longer story and one that is necessary to make the most informed decisions today. Thus, this literature review provides a brief look at the history, and how I have identified a gap in the research that will not only contribute to the field, but also inform our own local decisions.

The irony of co-op history is its roots in engineering, as it was originally created to fulfill the specific needs of engineering education. Here, one hundred years later, one might assume that engineering co-ops have been adequately covered by the plethora of research, but I am coming full circle and returning to engineering cooperative education, with a new focus. With the societal trends and the gendered norms of this historically male dominated field, women in engineering is still a topic with unanswered questions. After a slow start, co-op research eventually began to focus on populations, rather than assuming the initial research was applicable to all students and programs. As other majors adopted cooperative education, the

research had to follow and there was some clarity that diverse students had diverse needs, meaning it could no longer be done with a one size fits all approach. There was evidence for the need to prepare students differently, and that students may have very different experiences in the workplace, thus there may even be different outcomes. However, to adequately identify those differences and the experiences of students, the research must move away from focusing so heavily on quantitative studies and incorporate more qualitative methods. The research on women is no exception and requires an even greater need for qualitative studies. Women should have a chance to share their stories of the co-op experience so that we, researchers and practitioners, truly understand their unique challenges to respond appropriately. The need is much bigger than cooperative education - the lack of women in engineering is of national concern. Here lies an opportunity to contribute to the efforts of recruiting and retaining women in engineering.

COOPERATIVE EDUCATION BEGINS

The Legacy of Herman Schneider

Cooperative Education is an educational concept with a history of more than 100 years. In 1906, cooperative education was developed and implemented by professor Herman Schneider at the University of Cincinnati. This method of education did not come without a lot of research, thought, and conversation, as he had worked diligently to identify what engineers were missing in their education and the methods necessary to administer that

which was missing. “Schneider travelled up and down the eastern part of the United States, during his free time, talking with professional engineers, industrial managers, and engineering faculty members. He was trying to understand what was needed, what was then missing, in the education of potential engineers” (Barbeau, 1973, p. 59). The first model of cooperative education had engineers working in industry, alternating weekly between on-campus study and off-campus employment. This method combined a student’s academics and practical work experience, with the advantage being the work experience was obtainable while still a student. The term “cooperative” was used to signify the relationship between the university and industry, as an agreement was absolutely crucial. Schneider’s original model had two goals, as Wilson (1961) identified. First, to ensure students had an opportunity to learn elements that were impossible to learn while sitting in a classroom. And second, he wanted to find work experience for students that better matched their career goals, as compared to a part-time job, yet could be done on a part-time basis while still a student. Immediately, the goals were met because students did indeed have the opportunity to learn new skills through meaningful employment while maintaining their student status and meeting their academic requirements.

Early Co-op Benefits

The benefits to the student were immediately clear, because this was a method of learning that was very specific and necessary for their field but

impossible to replicate within a classroom setting. The students were not the only ones on the receiving end of the benefits. Institutionally, the faculty learned of their own relevance as students came back from their work sites with insider knowledge from the front lines of industry. The faculty received a first-hand, insider perspective on the current practices in industry, in addition to receiving immediate feedback as to their pedagogical effectiveness (Barbeau, 1973). With such success, the model for cooperative education was adopted by other schools, though slowly at first. By 1919, there were 10 institutions with a cooperative education program. World War I brought the first decline, with the country's resources directed towards the war. However, this point in history did not end cooperative education, because the war only brought attention to the even greater need for engineers. Thus, after the war there was more interest than ever in how to produce more engineers, and the answer again pointed to the combination of theory and practice.

Co-op's Flexibility

Co-op had the flexibility to respond to societal needs, and new programs were developed to meet the needs of both the schools and the businesses involved. In 1926, Antioch College was the first non-engineering school to begin a cooperative program and remains a large part of cooperative education's history. "The emphasis at Antioch was not as much on the specific vocational skills that could be learned nor the amount of money that could be earned, but rather on the importance of the work experience to the

understanding of life” (Barbeau, 1973, p. 93). Other non-engineering schools soon followed. In the 1920s, “Cooperative Education was viewed more as an educational method and less as a way of learning specific skills and earning money for tuition” (Barbeau, 1973, p. 98). With the respect cooperative education earned as a valid method for learning, the first professional association was formed in 1926 - the Association of Cooperative Colleges. In 1929 it became a part of the Society of Promotion of Engineering Education (ASEE). (History - CEIA) Despite the belief that cooperative education was only pertinent in times of economic plenty, during the Depression, less than one-third of the operating programs discontinued and new programs were born (Barbeau, 1973, p. 98). In one early study (1937), between 1928-1934, 51% of students were employed with the company they worked for as a co-op student (Barbeau, 1973, p. 104). As is the case today, employers were able to assess the students prior to a full-time hire which made them more confident when hiring that student for a full time position. Even students made better decisions as to the best fit for themselves with the additional knowledge gained during a co-op. Very early the outcomes and benefits emerged, as experienced by the students, the company, and the university. In these first 40 years, this method of education continued to grow and as shown, the benefits were very clear. However, the research to confirm the benefits and move beyond anecdotal evidence was slow to follow.

COOPERATIVE EDUCATION'S EARLY PUBLICATIONS AND RESEARCH

Defining Co-op

Cooperative education had early goals established and its success in meeting them along with benefits to the students, university, and industry were relatively easy to identify. What was not clear were the processes in place to ensure those goals would consistently be met. In addition, the co-op processes may have been different depending on the context, so it was crucial to identify what changes were necessary to better meet the objectives. One flawed assumption is that every student will need and gain the same from a co-op, because demographics, culture, socioeconomic status, and other factors may significantly affect the student's experience. These differences in co-op results would become clearer with a greater variety of students participating in co-ops. In 1947, a key document was published, "The Cooperative System: A Manifesto." This was a successful attempt to compile what had already been happening into an official statement by the ASEE's Cooperative Education Division. In this document, cooperative education was defined, in addition to the purposes, advantages and requirements (Freund). Considering this was one of the first official publications on co-op, the gaps were evident. One missing piece was the focus on the results at the expense of the processes. "However, these advantages do not seem to bear directly upon the educational process; rather, they are incidental results of the cooperative method" (Freund, 1947, p. 126). As we will see during this stage of the co-op research, the

educational process will continue to be left out, even though it was clear that there were processes in place that played a role in the level of success. Research was necessary to better understand the processes and factors related to the benefits, but it would take nearly 30 more years for this to happen.

The Contemporary Period, 1957 - 1980s

Once cooperative education reached its 50th anniversary, the next goal was to gather greater attention, so a conference was held and a study was published in 1961 - "The National Study of Cooperative Education." (Timing could not have been better as universities were in a slight panic over upcoming increasing enrollment numbers, and cooperative education could provide some relief. When co-op students were off campus, there were fewer students on campus, thus the resources could remain steady and still sufficient if a portion of the population were off campus each semester.) The study (Wilson & Lyons, 1961) published in the text *Work-Study College Program: Appraisal and Report of the Study of Cooperative Education*, reviewed existing working models, offered details and recommendations for new program development, and included the employer perspective. Though cooperative education had been deemed effective based on participants' testimonials, by this time, "no real evaluation of philosophical purposes and broad values and no comprehensive documentation of methods and results have ever been carried on in regard to work and study interrelatedness"

(Wilson & Lyons, 1961, p. 3) As a result of the study, the committee was able to clearly identify eight educational values of cooperative education.

1. Students find greater meaning in their studies
2. Increases student motivation and interest in academic work
3. Contributes to a greater sense of responsibility, judgment, and maturity
4. Develop a better understanding of others and practice skills in human relations
5. Provides an orientation to the world of work: career options, vocational insights, self-aptitudes
6. Attracts some to college who may not have otherwise been able to afford it
7. Direct access to industry for the faculty
8. Efficient use of university resources when a portion of the students can be gone from campus

These values are still relevant today and the research has done an adequate job with the quantitatively measurable values, but what began here is an assumption that the benefits are accessible to all who participate in co-ops.

This assumption is flawed because the values will differ from student to student. While all these values are important to students and their universities, some of these values will be pivotal for certain students. Thus, the components of a co-op program need to consider the students involved.

Just sending a student on co-op without careful attention to the policies and practices may not meet the needs of every student without well-researched data to guide decisions every step of the way. This requires research focused on developing a holistic and detailed view of student experiences and needs.

The First Professional Co-op Organization and Journal

With the success of the report, the National Commission for Cooperative Education (NCCE) began in 1962 to promote cooperative education nationally. (Sovilla & Varty, 2011, p. 5) The Higher Education Act of 1965 provided significant funding for cooperative education, and with the additional funding, the number of co-op programs went from 60 in the early 1960's to 277 in 1971 and then 1,012, the peak in 1986. During the major period of growth, there were two additional key moments. With the attention garnered by Wilson & Lyons study, it was an opportune time to use the increasing interest and begin a national association of dedicated professionals in which to guide the efforts of cooperative education. With its initial focus on engineering, this group was also hopeful in expanding cooperative education to other disciplines. (CEIA History) Thus, the National Cooperative Education Association was formed in 1963. From this group also came the *Journal of Cooperative Education*; its first edition was published in the fall of 1964 and intended to be a "scholarly journal to serve the field of cooperative education" (Miller, 1964). Establishing the journal was the first step in moving

cooperative education towards a legitimate, research-based field in higher education. The journal's first edition had a heavy focus on establishing the credibility of cooperative education, both in higher education and engineering education. In one article, Freund (1964) called for engineering education to turn back some of its focus towards "engineering art" or the practice, as attention had been shifted to the sciences after the Grinter Report. The Grinter Report encouraged higher education to shift its focus towards the science of engineering rather than the practice, yet Freund argued that practice was crucial and cooperative education was the opportune method of engineering art. Volume two included one school's reflection on their program's first year, a student survey, a coordinators' survey, and the effect of cooperative education on students' persistence and academics. The survey as a co-op research tool and these particular topics would continue, even appearing in current research.

The next major publication came in 1971, *The Handbook for Cooperative Education*. (Knowles) With co-op's growing popularity, consensus on the details became important, thus the handbook served as a tool for the development of new programs. As the authors made clear, these were not clear-cut rules that had to be followed. Topics included:

- Comprehensive description of philosophy and objectives
- Development and administration of programs

- Operating procedures
- Relevance to special groups (Women and Minority Students)
- Academic, general, and financial administrative practices

With this text, there was a minor shift. Recommendations were made based on the context of the university, and even included two specific populations: women and minorities. This was an early indication that cooperative education could not be implemented with a one-size-fits-all approach, and research was necessary to better understand the programmatic components that require the most attention depending on the context, especially for special student populations. By the 1970's, cooperative education was something to be proud of for those involved.

Cooperative education has survived and prospered because of that very uniqueness. It is relevant, it is innovative, and it is student oriented, not only through its built-in financial-aid feature but through its individualization of the educational process as a whole. No other type of higher education in the world can make those claims (Knowles, 1972, p. 335).

In the 1970's, the Accreditation Board for Engineering and Technology (ABET) "adopted accreditation criteria for engineering and engineering technology co-op programs. These were the first discipline-related accreditation standards established for co-op" (Sovilla & Varty, 2011, p. 6). In 1994, the ASEE cited the establishment of cooperative education programs

as the second most important event in engineering and engineering technology. (Sovilla and Varty, 2011, p. 11) The first National Conference on Cooperative Education took place in 1971; the first World Conference on Cooperative Education was held in 1979; and the World Association for Cooperative Education (WACE) formed in 1983. (History, CEIA) This association formed with three goals: to bring together educators and employers in cooperative education from around the world; provide a biennial world conference, and distribute a world-wide newsletter. (History, WACE) In 1999 another global initiative came forth; the Asia-Pacific Journal of Cooperative Education began with the goal of providing an accessible “developmental journal” for those up-and-coming, so as not to be discouraged due to their lack of experience as published researchers. It was also the first international collaboration to specifically target those in the Asia-Pacific region where co-op research was only in its infancy, yet the research was occurring. (Zegwaard, 2012) Since then it has maintained some of its initial goals; it is online and open-access and it continues to grow. This journal has provided access to global cooperative education research. In this journal, it is evident that the research is addressing fields other than engineering and specific cultural populations. In the most recent issue, there was focus on Thai, German, South African and Namibian students. With cooperative education having spread to nearly all majors, the initial literature that approached the educational method for engineering is outdated and co-

op research more often focuses on particular programs or populations, with the results providing practitioners the research necessary to make more well-informed decisions.

Co-op Research, 1988 – Current

The problem with the research as of 1988 was its narrow scope and the lack of big picture theorizing and assessment. Twenty-five years after the first co-op study was conducted and published in 1961, approximately 200 research projects had been published when Wilson (1988) provided an update on the state of cooperative education research. Having been a part of the initial research group that was taxed with proving the educational merit of cooperative education after its 55-year existence, Wilson (1988) reviewed the research that had come since and identified the gaps, and more importantly, the reasons for those research gaps. In 1988, the research had been restricted to “applied, survey research, motivated by immediate, pressing problems encountered in the day-to-day operation of cooperative education programs” (Wilson, 1988, p. 84). This plethora of survey research did not provide an encompassing, holistic view on the student experience. At this point, there was some research focused on specific groups of students and the outcomes specific to their needs, but it was mostly quantitative studies. With only numbers, it was difficult to understand the similarities and

differences amongst the students, and the realities of the co-op from the students' perspective.

At the expense of the holistic view, research targeted quantitative, tangible benefits. The problem was that these outcomes do not explain why the student is more valuable, how the student learns, and what factors have the most influence on the success or failure of the student's experience. In 1993, Ricks, Cutt, Branton, Loken, & VanGyn provided their perspective on the state of cooperative education and its research, specifically the weakness of relying on what practitioners believed was happening based on anecdotal evidence and trends. "The cooperative literature tends to demonstrate what is **believed** about cooperative education that is similarly defined, rather than what has been substantiated in cooperative education research" (Ricks, et al., 1993, p. 11). As was the case in 1988, they identified process as a major missing link. "Nothing is known about cooperative education in term of its educational process or how it works to benefit students" (p. 18). While it is clear there are benefits, the reasons and methods leading to the benefits had yet to be included in the research. Three benefits that were well researched with quantitative studies were salary, GPA, and retention, because they were easy measurements. One unit of measurement was salaries of full time employment after graduation for those with co-op experience compared to those who had not. Research showed a difference, at times significant,

between the two groups, with co-op students securing an increase in their starting salaries (Rogers & Weston, W.D., 1987; Vickers, 1990; Blair & Milea, 2004). These higher salaries can be attributed to the students proven experience and success in the workplace. This benefit was especially important to the students, but co-op benefits go beyond the dollar sign. Prior to student's' departure from the university, a key goal for the university is student retention. Quantitative studies have been done to compare the retention rates (Avenoso & Totoro, 1994), and it is the co-op students who show higher retention rates. Grade point averages have been another measurement tool and co-op has shown an improved performance in the classroom. (VanGyn, Cutt, Loken & Ricks, 1997; Blair & Milea, 2004). Clearly, the benefits had been adequately established, but it was time to move beyond just numbers and determine what happened to the student to produce those benefits. Beginning in the late 90's, research finally began to address some of these issues. Pedagogical methods became a part of the conversation, especially reflection, and the application of educational theories in a co-op context to better merge theory with practice. (Haddara & Skanes, 2007) Learning theories would be one theme that would continue to appear because it provided important insights into how students were learning and the effective pedagogical methods. These contributions were foundationally important, but there was still more to learn regarding the students' experiences.

Introducing Self-Efficacy

One additional area of research that is worth mentioning is self-efficacy, because when it appeared in co-op research, it provided a quantitative measure for one of the early values that had not been part of the research. Self-efficacy can be applied to different aspects of the student, thus providing a way to quantify how their academics, work skills, and career skills were affected by the co-op experience. There are quantitative research tools that provide a number as to whether a student becomes more, or less, confident in their ability to complete a task. A number of researchers have connected co-op and self-efficacy (Fletcher, 1990; Chung, Chang & Chiu, 2008; Drysdale & McBeath, 2014; Reddan, 2015; Thompson, Bates & Bates, 2016), but Raelin et al. (2007; 2011; 2014) has been quite prolific in using this notion of self-efficacy and conducting research with students in engineering. He utilizes three different types of self-efficacy: academic, career and work. While there were others who measured self-efficacy in specific contexts, such as “career maturity” (DeLorenzo, 1999), Raelin’s work has been able to provide an extensive study that measures self-efficacy in those three different areas as they pertain to a co-op experience. Raelin’s most significant findings in self-efficacy have to do with work self-efficacy. Work self-efficacy are those skills that are expected and necessary in the workplace, and different from the academic or theoretical knowledge gained during one’s education. “Work self-efficacy measures a range of behaviors

and practices – e.g. exhibiting teamwork, expressing sensitivity, managing politics, handling pressure – attending to students’ beliefs in their command of the social requirements necessary for success in the workplace” (Raelin, et al., 2011, p. 30). Raelin, et al. (2011), supported by a grant from the National Science Foundation Research on Gender in Science and Engineering, wanted to “determine the effect of self-efficacy and other factors on the retention, especially of women, in undergraduate engineering programs” (p.18). The team measured all three areas of self-efficacy (academic, work, and career) and found differences in students’ work self-efficacy, whereas academic and career were equal between co-op and non-co-op. Drysdale & McBeath (2014) found no significance difference in self-efficacy, while Thompson, Bates & Bates (2016) noticed the differences in work self-efficacy were less a result of a work-integrated learning experience and had more to do with overall experience. These skills associated with work self-efficacy are critical in a student’s workplace success, yet it is a mistake to assume that students are equally prepared. Self-efficacy is a key outcome of cooperative education, and Raelin’s work made a significant contribution to the field in understanding how the co-op contributed to the acquisition of work/professional skills. Specifically, Raelin is one of only a few who are focusing their work on women in engineering and the co-op experience. As is the trend, co-op research has to address specific programs

and populations, and for both the local and national context of my work, there is not a more pressing issue than women in engineering.

WOMEN IN ENGINEERING

With co-op history resting so firmly in engineering, what's left to talk about?

We need to talk about the women. Considering how far we have come in other STEM fields, the number of female engineers has not caught up. In fact, in very recent statistics from the National Science Foundation (2015), women represent only 14.9% of the engineering workforce. Overall, the STEM fields are not completely deprived of women, there are actually some with near proportional showings (Cummins 2015). However, engineering is at the bottom of the list, with the lowest percentage of women. In our universities, the numbers aren't much better. According to a 2014 NSF Study, females earned only 19.8% of the engineering degrees awarded, with the average since 2004 being only 19.2%. Only a very slight increase had occurred over the past 10 years. In 1965, H. Russell Bintzer, Vice President for Development at Carnegie Institute of Technology spoke at the Cooperative Education Association, where he addressed the crowd as his "co-op buddies." In 1965, less than 1% of the engineers were women. However, if we are to take the advice that Blitzer (1965) provided in his address to the Cooperative Education Association, "co-op education must be weighed in terms of today's students; today's society; today's problems"

(p. 4). Today's need is women in engineering, because despite the slight growth, it just isn't enough.

Workplace Realities of the 1970's

In the 1970's, women in the workplace were experiencing the repercussions of the myths and barriers that limited their opportunities and affected their day to day work lives. Thus, what was written about women and co-op offered evidence and research studies that tried to determine how cooperative education was assisting women in overcoming these barriers. In the 1971 *Handbook on Cooperative Education*, there was attention given to special populations, one of which was women on co-op. This insider information had come from the cooperative education work supervisors. The chapter's author, Harriet Sickle, identified cooperative education as a method to break two major gender barriers for women - "the opportunity to enter new career fields and the opportunity to gain equal pay for equal work" (p. 269). Even today those goals seem spot on, but the chapter went on to highlight gender stereotypes - such as the expanded pool of potential husbands through co-op, and the specific problems women caused, insisting on higher wages and a more noticeable intolerance for bosses and co-workers. This was the first indication in the research of the unique co-op benefits for women and these benefits were critical in significance because they addressed the current gendered workplace issues. In 2016, Sickle's goals for cooperative education are still valuable because that type of workplace

discrimination and inequality do still exist. However, the benefits have changed; an expanded pool of potential husbands is not anything we would advertise today. Most disturbing from this chapter were the problems, as cited by the supervisors: women insisted on higher wages and showed a noticeable intolerance for bosses and co-workers. I cannot accept this stereotype as it is stated here. Were women really less tolerant and more likely to leave for insignificant reasons? While women may have been more likely to leave, I would argue there was probably more to the story. When supervisors used the term “grouchy bosses,” as was the description for those women who could not tolerate their supervisor in the workplace, perhaps he was much more than grouchy. If a woman experienced discrimination or sexual harassment, she may very well be more likely to leave, without providing the most accurate reasons for fear of repercussions. Unfortunately, there is no access to the insider information because the women’s voices are not yet a part of the research. Immediately, even in this early publication we see the need for the women’s stories. Despite the goal of the co-op providing some type of gender equality for women in the 1970’s, the reality was that women were still working in a culture that limited their career opportunities and undervalued their worth based on their sex.

Mosbacker, W.B. (1973) explored the realities of working women and provided evidence for the changing world of work, women’s improving status,

and specific benefits, but simultaneously recognizing the work to be done. Throughout her article, she cites numerous quantitative studies that were done on women in the workplace and co-op situations, but most of the research asks everyone *except* the co-op women. First, one study by the state of Ohio asked employers about women in the workplace. The results were clear as to which professions were appropriate for women, the reasons employers did not hire or promote women, and reasons why they *do* hire women. The number one result was that employers hired women because they were “basically honest” (Mosbacker, 1973, p. 31). In 1973, an employer survey cited the female hires to be 35%, compared to hiring 19% more male college graduates. Another survey cited was a questionnaire to colleges and universities with cooperative education programs to collect the number of women on co-op, which was approximately 1/5 of all co-ops. Another study targeted graduates of the University of Cincinnati from the 1950s and asked them questions about the long-term effects of their experience. The results were that co-op “made a definite contribution to the student’s preparation for responsible permanent employment and for success in terms of service and social usefulness” (p. 37). The most recent survey had been done again with colleges and universities in the summer of 1973. The numbers showed an improvement in participation, with women now accounting for nearly one third, in 105 different majors. A key question asked about the differences in experiences for men versus women. “Do you feel that the significance of the

cooperative system of education is generally different for women than for men?" 90% of baccalaureate programs and 80% of two-year colleges saw no difference.

Most of the opinions of those who felt there is no difference in the significance of cooperative education for women as compared to men centered around the idea that no difference exists if the female is sincere in seeking a career because of the increasing awareness of the similarity of the goals of many women and men in our society which is tending to equate the training appropriate for achieving those goals (p. 40).

Those with the opposite opinion felt co-op provided women a chance to try out a career or a method for women to enter typically "male" positions. I cannot accept the results of this particular question because university co-op practitioners were not participants of the co-op experience. They were not there. They did not experience what the women experienced. This is not a question they should answer for the women, rather the women should have been asked. We need an opportunity to collect women's stories about their experiences and identify significant and unique ways in which their experience was different from that of their male peers. Overall, Mosbacher was pleased with the evidence pointing to increasing opportunities and enrollment for women in cooperative education, as was evident in her list of co-op job titles that she collected. But their titles are as close as we get. The

women who are being talked *of* in this article are not given an adequate voice to ensure their experiences are accurately represented. Without that, it is very difficult to find proper solutions that meet the women's needs.

Though quantitative methods were used more often, there was one researcher who gave the women a voice and an opportunity to share the details of their experience, which in turn could better assess the specific outcomes and ultimately any unmet needs. Done by Northeastern University, "Meanings of Work to Women Students in a Cooperative Education Program," Kany (1973) conducted interviews with eighteen upper class women from both traditionally female and male fields. Their stories provided the researcher three identifiable trends from their responses. First, these women were seeking equal economic opportunity, yet they did not consider themselves to be a part of any women's liberation. The second theme was a lack of knowledge regarding job market realities. Finally, these women had an expanded view of the career potentials that were available to them, thus their choices were also being altered. This was the first of a lengthier study, but these insights are critical to our history of cooperative education research because it is one of the first, and few times, we hear directly from the students, and even better, women. But after this study, it takes seven years until we focus on women again.

The Value of Qualitative Studies

The problem with strictly quantitative results was that the significance of the co-op experience tended to be of no particular difference for women, as shown in the results. Rowe (1980) explored the effectiveness of cooperative education “in preparing men and women for occupational achievement and satisfaction after graduation” (p. 51). The research method was a questionnaire completed by 400 mathematics graduates. Sadly, the results provided very little. There were no significant differences for the women, but the salaries were still unequal between men and women. This study focused on the outcomes of cooperative education in terms of salaries and satisfaction, but I will argue there are more than tangible quantitative benefits of cooperative education, and these benefits are even greater for women in engineering. Cooperative education research has to move beyond the focus on quantitative measures. While this type of research does have value, especially in establishing the field with legitimate research, there is room and a necessity to also use qualitative measures to learn what the numbers just cannot tell us.

With an opportunity to share their stories, we begin to see in the research that certain co-op values are more important for women due to the unique differences they may experience in the workplace and the potentially greater need for confidence, especially if they are in a traditionally male field. One of

the early participants of cooperative education, Antioch College, who continues to have a robust co-op program and research team, conducted a study on the co-op experience for Women's Studies majors and the heightened outcomes of the co-op experience when the placement was in a feminist organization (Egart, 1994). From Egart's experience as a faculty member, she had the perspective to both read and speak with the participants and found that the co-op experience had a profound effect on the women's identities. "In my work I have noticed that when women students have their experience as individuals valued and acknowledged, it seems to produce proud effects on sense of self" (Egart, 1994, p. 52). This work provided a new direction for women on co-op as she recognized the tremendous influence the co-op had on the women's self-confidence and independence. This is exactly where we should be looking. Here is an example of two outcomes of cooperative education that may be difficult to quantify because they are not tangible, yet so important. With qualitative research on the women's experiences, the profound effect co-op had on their identities is recognizable. There is a richness and depth to the stories which provide insight to truly understand their experiences as women. For women in engineering, their work environment may produce unique challenges, so their confidence and independence may play a crucial role in retaining them in the field. Without confidence, they may not continue, whereas if a co-op results in confidence, there may be a greater chance for the women to

continue as professional engineers because they will be better aware of and prepared for the challenges.

Differences in the Women's Perspectives

For women in engineering, the gender-based workplace challenges might lead one to believe that job satisfaction could differ significantly enough between men and women, so as to affect women's retention. Wilkinson and Sullivan (2003) studied first year students on their first co-op to test this hypotheses regarding job satisfaction and gender. As expected, the conditions were different for women, thus influencing their satisfaction. The women were more likely to feel they were treated poorly based on gender and they actually spent more time without work, as compared to their male counterparts. Based on those results, Wilkinson and Sullivan recommended providing tools to assist women in developing supportive relationships, consistency in ethical standards amongst students and employers, and tools to deal with gender discrimination. From this study, the next step was to determine whether increased job satisfaction for these women would retain them in science and engineering careers. This quantitative study provided the data to confirm some of their hypotheses and show the differences in a co-op experience between men and women, but again, might there be more to those stories? How would the women have described the gender discrimination they experienced and what might their solutions be? More qualitative data is the next step if we want to understand the women's

perspectives. Upon review of the literature on women in co-op thus far, there are adequate results to show the significance of this topic and the value in continuing to better understand and ultimately prepare women for their experience as a female co-op engineer. There is also a gap here to be filled - co-op practitioners can better understand the co-op experience for women in engineering and more effectively respond based on the research and theory I will contribute.

Timing could not be better in addressing the need for new and creative solutions for the shortage of women in engineering. As the gaps indicate, there is a need for research using qualitative methods that provides women the chance to share their stories of the co-op experience to those interested in responding, ultimately allowing a better understand into the women's realities. Fifolt & Abbott (2008) identified the potential of co-op programs to serve in increasing the representation of women and minorities in the sciences and engineering. Their research focused on mentoring through a mixed methods study. Their findings made it clear that the needs of women and minority students were not being met at the institution of study. But as the history has shown, this is not surprising. "This is not surprising considering the fact that co-op programs continue to be overwhelmingly dominated by white males and were originally developed for white males by white males" (Fifolt & Abbott, 2008, p. 261). With the mentoring component

being key to the co-op experience, especially as it relates to self-efficacy, both co-op program's structures and programs should be carefully assessed to more inclusively meet the needs of women and minority students. This work is important in confirming the importance of studying women in engineering who are on co-op, because as shown, while it is not the only tool to our national shortage, it is but one area that has the potential to make a difference in balancing the gender gap and filling the employment needs.

In 2011, Zegwaard and Coll published an article in the APJCE on the current issues of cooperative education. They had seen some of the research gaps filled during the last two centuries, specifically on theoretical framework development and the advances and dissemination of new knowledge, but specific research areas they identified as requiring attention were student learning, assessment of learning, and relationships between cooperative parties (10). Howard (2012) urges those in the field to make research a top priority.

In order for research to have a more prominent place in the field of cooperative education, co-op educators need a diverse range of more sophisticated models that attempt to describe and understand the complex cognitive, social, and career-building outcomes of alternating work and study and how these outcomes happen (p. 6).

Zegwaard (2015) notes the advancements since the reviews of 1988 and 1997, but identifies gaps which require attention: workplace context and colleagues, new learning modes and technology that may be valuable for delivering cooperative education curriculum, integration, and a curriculum that explicitly works to produce students as “agents of change” (94). When I see these lists of current needs in our co-op research, I see women in engineering as one population that fits these gaps. Zegwaard’s workplace context would align with my call for more qualitative research on the co-op experience for women in a male-dominated workplace. Workplace context is highly significant for women in engineering and it is partially the responsibility of the universities. We have the opportunity to contribute in better preparing women for their professional careers. Their workplaces are different because the influx of males provide a different type of working environment, and one in which we can better prepare the women to enter, even as early as a co-op. Using interviews, Leventman and Horst (1985) did a study on women in engineering. Their goal was to address the role of co-op in preparing women for their career and the impact on their career development. The stories they collected told of the workplace realities and concluded, “there would seem to be no substitute for the kind of practical, hands-on experience co-op provides” (p. 213). While this sounds like a replica of any description of co-op benefits, we have to better define what the practical, hands-on experience means for women, because it is different than men. Another potential area

that aligns with women in engineering is the notion of “agents of change.”

Women in engineering may experience the repercussions of gender bias, stereotypes, and discrimination, but we can also prepare them to respond as agents of change, which in time, may eventually shift these workplace cultures.

CONCLUSION

When we look at the numbers, in more than thirty years, the representation of women in engineering grew by only 8.2% (5.8% - 14%) between the 1980's and 2012. (Crawford, 2012) In the most recent numbers (January 2017) from the National Science Foundation, there are 250,000 employed female engineers and 1,469,000 male engineers. Clearly, women are slow to close the gender gap in engineering. In a 2012 ASME article, three possible reasons were listed for the lack of women: the lack of engineering role models, a misconception of engineering, and fewer opportunities with technical problem solving in grades K-12. While a Stanford study found two additional reasons: women don't believe their skills suffice nor do they feel like they fit (Crawford, 2012). In this study, I will provide insights into the experience of 11 female co-op engineers, including stories of feeling inadequate and difficulty fitting in. Those are the statistics and these are their stories. But through these stories, there are also positive descriptions of role models, shifting realities, and increased confidence. Cooperative education

does show potential in helping to increase the percentage of women employed as engineers.

The Marriage of Cooperative Education and Feminism: Uncovering a Fresh Perspective

As previously established, co-op has a lengthy history with roots in engineering. But despite the time and the previous research, there are still gaps, especially for co-op women in engineering. Thus, this study is not only filling these gaps, but also approaching them with a new twist, a feminist twist. If we study women in co-op with a feminist framework, what do we learn that has been previously overlooked in quantitative co-op research? A quantitative study may not be capable of providing the full story, and it is necessary to understand the realities of the workplace for female engineers on co-op. With a feminist framework, we may ask different questions, see the data differently, and most importantly, provide an opportunity to the women who are participating in co-op to tell their stories. There is no question that for women in engineering, gender does matter. Each year, *SWE Magazine* does an annual literature review. “The purpose of the annual literature review on women in engineering is to present the readers of *SWE Magazine* a summary of the best scholarly research on the position of women in engineering and related fields” (Meiksins, et al). In the 2015 review, the results were clear in identifying the presence of gender-related issues in the workplace. Considering then these workplace environments, we cannot be satisfied with the results that tell us gender does not matter. Because the

elusive nature of the current bias and discrimination allows some to deny its existence, we need to understand the ways gender does still matter.

Why Talk Gender

Rarely do we hear about gender as a part of the co-op experience. For female engineers, however, the skewed and unbalanced gender ratios in their worksites is their reality. However, I failed to find an abundance of research on cooperative education and women or even trans-gender, which I found problematic. (Though I will not include a discussion on the transgender community and their experience, this is valid direction for future research to further question how gender affects their co-op experience.) The limited research that was available on women in engineering typically showed results that concluded gender was not an issue, or gender had only a limited effect, but most of the evidence for this claim draws on only one type of method - quantitative - and thus investigates the issue inadequately, from only one perspective. I will bring in an alternative perspective. As female engineers from Michigan Tech leave campus for their co-op work sites, they enter male-dominated workplaces where the representation of women is minimal, and the unbalanced ratios were accompanied by the possibility of lingering stereotypes, gender bias, or at the very least, unrecognized androcentric policies and practices. The reality and the research does not add up. The problem, however, does not end there. Not only is there limited research on co-op women in engineering, but the little research that is

available relies heavily on quantitative methods which tended to show little or no difference in the co-op experience for women. Taking these results at face value and continuing to work under the guise that co-op is the same for all, the problems begin to add up, and there are layers left uncovered. The approach that I propose to uncover these layers and disrupt these assumptions is with a feminist theoretical framework that utilizes both quantitative and qualitative methods.

For many, even the women themselves, they may want to believe that we are beyond *feminism* or discriminatory workplaces, but statistics tell us otherwise. The women's experience is different, even causing some to abandon the field. In a 2016 culture study conducted by SWE, they looked at sources of female attrition, and there were clear differences between male and female experiences. "This contrast between what women want and what they experience demonstrates a major misalignment between their values and what their organizations endorse." Regardless, at times women may tend to avoid identifying themselves as feminist because of the fear they may be seen as inherently radical or complaining. Rarely do we see the marriage of feminism and engineering. However, a feminist approach is not radical nor complaining, rather it tells us there is a need for something different and offers different methods. Some of the changes that have been previously utilized to fight the imbalance of gender in engineering is more women, but

this is not enough. The goal cannot merely be more women because when the women arrive, then what? For some, women in engineering may find a full time position, but at what cost? They may be hired as women, but some may feel it necessary to shift their identity to better fit into their highly masculine culture - they may feel the need to be seen as one of the boys. Women are not being overtly excluded from the profession, but only access is not sufficient or at least it shouldn't be. By taking a feminist approach to women in engineering, and the co-op experience specifically, this provides a new perspective and fresh solutions that may have been impossible to identify with other methods. Only when we begin to look differently will we see differently. New insights uncover how women on co-op may experience their workplace, the results of their experience, and the opportunities to respond and begin to make a shift. If we accept the current limited results and believe that the co-op experience need not be explored in terms of gender, then co-op is co-op, and the engineers we send out are all just engineers. I will not accept this approach and I would argue that it is not fair. This is a dangerous space in which to rest because not only are the women left out, but the larger university, industry, and societal policies and procedures may be left unexamined. Thus, if we continue with the current status quo, the outlook for women will not change, nor will there be a recognition that there is a need to change. I want to dig up, turn over, and

observe from a different vantage point in order to learn more about the experiences of female co-op engineers.

To proceed, co-op research must consider gender carefully to be sure that results are not skewed due to the advantage of men in merely numbers. In one study on the composing practices of students in an engineering course, the danger in accommodating the majority (men) becomes eerily clear.

If we do not differentiate between the male and female students in the class and do not take into account the fact that engineering is a male-dominated discipline, the mere fact that men outnumber women in the class will allow men's problem-solving and discursive practices to define the standard, the reality against which individual performances are measured (Sullivan, 1992, p. 52).

Though a slightly different context, what is at stake is the same. When we neglect to listen to the minority voices, the standards in favor of the majority will never be undone and we miss out on vital insights from those left in silence. The male students were greater in number, thus greater in voice and could easily overshadow the women. The caution Sullivan provides is to not allow standards and practices to be determined by those in greater number, but be sure that others present also have a stake in defining standards.

From Where I Stand

Considering the feminist framework from which I am working, it is imperative that I make my own position clear and identify what I bring as the researcher. While scientific methods strive to maintain an objective view without bias, the key to the type of research I propose is to acknowledge the biases and background of the researcher. I must identify what I am bringing to the research as much as the subjects of the research. "The researcher's own race, class, culture, and gender assumptions are not neutral positions from which he or she observes the world but lenses that determine how and what the researcher sees" (Sullivan, 1992, p. 56). As a researcher, part of the process is to identify one's own position in relation to the subjects who are being researched. I am the Assistant Director for Experiential Learning and Career Development in the Career Services Department of Michigan Technological University. In this position, I oversee the Cooperative Education program, which entails program oversight, student eligibility, program procedures, and course instruction. Considering my position, it is important to understand the power and authority at play between the students and myself. From their perspective, I make important decisions for the program, but also serve as the instructor for the graded course they were required to enroll. While I would hope that my position did not affect their participation, I have to acknowledge the possibility that power and authority may have affected portions of the data.

Another aspect of my own stance worth mentioning is the lack of industry experience I bring. I am not an engineer nor even in the STEM fields, plus I have never worked in industry myself, instead having had a career in higher education. The closest connection I have to their co-op experience is a student teaching requirement during my English Education undergraduate degree. Though the goals are similar, experience in a realistic work setting, the settings and clientele are much different. There are enormous differences between public high school students and industry professionals. Without the industry experience nor the degree, I often felt I did not bring enough insider knowledge. But rather than focusing too heavily on this being a detriment, I instead approached my work with the assumption that I had a fresh, unscathed perspective from which to view their experiences.

The last part of my own identity that is important to acknowledge in this research is my gender. It would again be easy to assume this was enough to provide a connection- we are women. Haraway (1991) and Harding (1991) caution heavily against leaving it as simply biology. Woman does not equal woman, and merely being a woman does not ensure alignment with another woman. I will provide a more in-depth discussion on feminist standpoint theory, but at this point, I only want to acknowledge both my identity as a female, but also my own caution in leaning too heavily on this. Woman is not all inclusive and identities are much larger than strictly women. In Haraway's

(1991) argument, she moves beyond the division of sexes and even further, beyond labels. Both have provided structure and boundaries that are unnecessary, yet create divisions. When we use *women*, many have actually been left out. "There is nothing about being 'female' that naturally binds women" (Haraway, p. 155). We must be careful not to compare and represent women's experiences as one experience, as this may actually counteract the goal. The key is to move away from this dualism and her notion of cyborg is meant to do just that. "Cyborg imagery can suggest a way out of the maze of dualisms in which we have explained our bodies and our tools to ourselves. This is a dream not of a common language, but of a powerful infidel heteroglossia... It means both building and destroying machines, identities, categories, relationships, space, stories" (p. 181). By erasing boundaries, there is more we can do together. We miss so much when over-emphasizing the gender category. The experience of each female engineer is not the same, as their identities are much greater than only female engineers, thus a lot more will affect their experiences in the workplace. There are other aspects that affect both their identities and their co-op experience. Haraway's cyborg imagery provides a new perspective and an important warning for anyone focusing research on gender. The fact that this study is focusing on women already contradicts the call to avoid the division by gender. However, clearly it is impossible to completely erase those boundaries, but we can be more careful in our approach and the

tendency to rely too heavily or assume that woman means all women.

Haraway's point is important to keep in mind as we proceed through this research as a fair warning that there is much more at play beyond only gender.

One additional note on myself and the participants is that while we are women, we are also white, Western, middle-class students and staff from a respected research, but rural, university. Our perspectives are somewhat homogeneous and much more aligned with the majority. This could bring a potential flaw. Both Haraway (1991) and Harding (1991) warn against women only coming from the majority. "It is necessary to decenter white, middle-class, heterosexual, Western women in Western feminist thought and yet still generate feminist analyses from the perspectives of women's lives" (Harding, p. 13). And while I cannot bring but what I am, I was also limited in terms of the women available who qualified for this study. Regardless, it is worth noting that I acknowledge this, understand, and will consider future research directions. Overall, my own identity is a part of this research and important to continually acknowledge to clarify how it may be at play in the research process and results. In a later discussion, this point will be clarified using both a feminist inquiry and a grounded theory method. Charmaz (2014) notes, "What you see in your data relies in part upon your prior perspectives. Rather than seeing your perspectives as truth, try to see them as

representing one view among many” (p. 132). Thus, this will be one view among many, but one I hope will give a voice to many otherwise left unheard.

Based on the context of my own work, I want to next share how I will use the results of this research. Prior to the start of this study, I had only been in my position for one year, and a lot of the policies and practices had been in place prior to my arrival. Little by little, I noticed potential changes to better serve the students. One particular group I recognized with unmet specific needs were international students. Based on workplace cultural differences, it made sense that there was a need to address issues and concerns that may be unique to the international student’s experience. However, women were not as obvious. In our department, never had we discussed women, nor any issues surrounding the gendered experience of co-op. While the ratio of men to women clearly favored men on our campus, this was not a unique trend and ultimately, not our problem. We prepared students for their co-op. But overall, we assumed engineers were engineers. They had all been prepared by their academic departments, and it seemed as though all students required the same co-op preparation. It wasn’t until I began my own study and explored the research available on the co-op experience for women, or lack of. Very quickly I noticed there was not a lot to be found, yet based on the circumstances and national trends, this was an area that deemed the need for attention and research. Though our department had not

give any attention previously, I now wanted to stop and question this assumption. Might women need more than what we were providing? Are we really satisfied with the current one-size-fits-all-engineers approach? Might there be valuable results if we considered doing it differently? With this research, I want to examine the co-op experience for female engineers and respond accordingly. I no longer want to assume that our program is adequate for all students, and more importantly, assume our policies and procedures serve all students. Without carefully considering the women participating, I cannot assume anything. With these goals, it is important to acknowledge that my own goals can affect the research itself. "Research reports reflect researchers' interests and agendas as much as they reflect on participants' performances" (Kirsch, 1992, p. 265). This is a point that is worth acknowledging, and in doing so, being careful not to look at my data with assumptions about what I need to find.

THE FEMINIST FRAMEWORK

For this research, my methodological framework and approach is seated in feminist theorists. With this framework, there is the opportunity to view the co-op experience of women from a stance that has been underutilized in a lot of the current research. These feminist theorists have encouraged me in how to conduct the research, how to analyze the data, and how to use the data for exploration, being careful not to force the data into a pre-existing theory. What is most promising with this is the opportunity to learn

something new, to uncover taken for granted assumptions, and to offer women something different with which they can ultimately make a difference in the communities they are a part of. A feminist framework will begin to uncover the assumptions, even some of those which are made by co-op practitioners like myself, and offer a response that provides access to the hidden assumptions and practices that may not be best serving the silenced minority.

If we begin with early feminist research, de Beauvoir, clearly establishes the status of women, the Other, in comparison to men. And in her discussion, she raises an interesting question, one which applies to women and science. “Why is it that women do not dispute male sovereignty” (de Beauvoir, 1994, p. 9)? As we explore the role of women in science, Harding (1991) makes it clear that women were in a supporting role, devoid of participating fully, and definitely not leading. But why? One reason de Beauvoir points to is the lack of unity and means for organizing.

The reason for this is that women lack concrete means for organizing themselves into a unit which can stand face to face with the correlative unit. They have no past, no history, no religion of their own; and they have no such solidarity of work and interest as that of the proletariat...They live dispersed among the males, attached through residence, housework, economic condition, and social standing to

certain men - fathers or husbands - more firmly than they are to other women (p. 9).

I begin here because there is still truth to this. Over time, while women have seen more opportunities and methods in which to change this, we have to be careful in assuming that the results can be as simple as putting women together. I found this to be most telling when the co-op women described their participation in and the benefits of SWE (Society of Women Engineers). Based on a few comments during the interviews, the presence of this organization and their participation were not as effective as may be expected in empowering women to work together. As many of the theorists will reiterate, merely access and organization is not enough for true change. These points are meant to provide some history and some insight into the role of women, the voice of an early key theorist, and a reminder of the lingering subordinate positions women continue to occupy.

Women and Science

In this section, I will first provide the larger context of women and science to showcase what has been the reality for women in the sciences, as well as the societal detriments with so few women playing a lead role. If we are to examine the current status quo for women and science, the results have only furthered the division between the few and the many. Harding (1991) provides a critique of the two approaches to science, "science as usual" and "bad science," with arguments for a feminist perspective to counter both

approaches. Without this feminist shift in the sciences, a small few will continue to participate, lead, and dominate the science, at the expense of everyone else. "Feminism highlights the hypocrisy and irrationality of these universalistic claims in the face of overt and tacit discriminatory practices" (p. 32). While my focus is on women, it is important to consider who else may be affected in addition to women. Though I will focus on women in engineering, this larger discussion of science and "whose science" is of utmost importance to establishing the need for a shift in how we do science, how we determine priorities in science, and how we research in the sciences. And as Harding establishes, "Women need sciences and technologies that are *for* women and that are for women in *every class, race, and culture*" (p. 5). The consequences of the current status are that the sciences are lacking and everyone loses without the full perspective that could be possible with more players involved. When we ask, what if we don't, Harding identifies the results. "If values and interests that can produce the most critical perspectives on science are silenced through discriminatory social practices, the standard, narrowly conceived conception of scientific method will have not an iota of a chance of maximizing either value-neutrality or objectivity" (p. 41). The current results are only to the benefit of a small group. Throughout her argument, Harding advocates for the sciences to shift and include, though not at the expense of all others, but include science that begins with women. "Thinking from women's lives provides crucial resources for the

reinvention of sciences for the many to replace sciences that are often only for the elite few” (p. 312). Harding's work provides a strong foundation for the necessity of including women in science work and research, but even beyond just including women, a deeper structural shift has to be made where the process begins and proceeds very differently.

What Feminism Can Offer

This call for a feminist approach comes with one major advantage - nothing is secret. As a researcher, I cannot cover up the lens from which I work. I cannot ignore the gender, race, and culture of the research participants. Feminism will put it all out there. “Put another way, feminist inquiry wears its heart on its sleeve: it originates in an ideological agenda that, instead of masking, it declares up front” (Sullivan, 1992, p. 57). This transparency is very different from how science and research has been done previously. When the deep underlying streams were left out of view, it was difficult to disrupt. It is near impossible to disrupt that which cannot be seen. When the standards and status quo go unchallenged, there will be gaps in the knowledge, there will be voices left out, and there will not be an opportunity to understand completely in order to respond accordingly. While standards can be useful, they put limits on what is possible. This feminist approach can help to break out of the status quo to explore areas that may have gone uncovered. Sullivan’s feminist approach to composition research provides useful points when we think about how to approach research with

students. “Feminist critiques may also challenge the ways in which we have traditionally constructed our stories, the processes by which we ascertain truth and impart knowledge to the larger research community” (Sullivan, 1992, p. 49). Most exciting is what may come from this type of research, as it is impossible to predict the results when there is the potential for something new, something uncovered. “As both an ideology and a praxis, feminism not only reinterprets but seeks to change the dominant, patriarchal structures and categories of experience that have rendered women’s activities and social relations analytically invisible” (Sullivan, 1992, p. 40). I would suspect that some may find this argument outdated and unnecessary because of the access women have today. But access is not sufficient. Providing access for women is not enough to ensure equality of experience. Equal access and equal opportunity, which some may argue is the case, does not guarantee that the experiences will be equal in a co-op workplace setting.

Why Cooperative Education Needs Feminism

In the 1971 *Handbook for Cooperative Education*, the chapter on women established the unique qualities of the co-op experience for women, which were somewhat different than those of men. Women were provided opportunities that fought against the cultural biases and expectations women were supposed to follow when preparing for their careers. Co-op provided access to careers that were otherwise very difficult, if not impossible, to break into. Co-op was an enormous advantage for women. But the outlook

also included cultural expectations that were not as forward-thinking. Benefits also included the opportunity to meet more men while on co-op. “Alternating periods of work and study enable women to meet both the boys on campus and the young professionals employed in their individual cooperative work areas” (Sickle, 1971, p. 267). Co-op offered women greater access to potential mates, the reality in 1971, but a feminist approach brings attention to the problem with this, even in 1971. Nowhere in co-op literature does the experience offer men access to meet more women or any other type of personal benefit. This is where we need to draw on the feminist lens to critique the issues and uncover portions of the co-op history that are still plaguing us today, creating situations of inequality less favorable for women. Simone De Beauvoir includes marriage in her argument. “Reared by women within a feminine world, their normal destiny is marriage, which still means practically subordination to man; for masculine prestige is far from extinction, resting still upon solid economic and social foundations” (p. 16). Men were completing a co-op for the experience they would need to continue their professional career upon graduation, with the likelihood that their future was that of a successful professional. Women, however, were not provided the same benefits. Men were provided professional experience, while for women, co-op provided further opportunity to serve in subordinate positions. The most women could gain was temporary access and experience; they had access as a co-op, but it was a position that was otherwise off limits.

“Through cooperative education college-educated women are gaining entrance into the professions, including those in what may be termed nontraditional fields of feminine endeavor” (Sickle, 1971, p. 267). The co-op was an opportunity to gain entrance, but not a guarantee of a professional future. Even the text makes it clear that women would have to choose their career paths more carefully because they could not expect a highly technical full-time position if they were to take time off in the future for a family. If they were going to take time off for family, they would be unable to keep up with the technological advancements in their field, thus they would not be able to fulfill those requirements. When women were planning their future, those plans were made around men and family. While the discussion in 1971 may seem very different from today, as it is clear that the benefits of the co-op experience for women today does not provide a greater pool of marriage prospects, this is the history that is lurking in the shadows. Many today may argue that opportunities are equal and the women are provided chances that are the same as those offered to the men, but without looking more closely and without a different framework, we cannot assume this the case. Perhaps we are not as far as we expected.

Nationally, female engineers are heavily outnumbered, both in the universities and worksites. (National Science Foundation, 2015) With the national attention on the lack of females in STEM and specifically

engineering, this is an initiative that cooperative education can speak to, and possibly provide small but significant changes to change the numbers. More importantly, co-op can prepare women to shift these cultures for more significant changes in the future. It is imperative that androcentric policies and practices are recognized, both in the universities and the workplaces. Only when these are recognized is there a possibility to take action and better prepare both men and women to shift them.

Since the boys club of the early co-op days, is there really much difference? What is different for the female engineers? Engineering and co-op have been married since its inception, so this method is built on an engineering setting, but women have been a limited topic of discussion. With that said, I propose a different approach, that of a feminist framework in order to produce something different. Nothing can change without change, so there is a need to do something different than what has been done before.

Feminist Standpoint Theory

If we are to learn about the women's lives, it would only make sense we begin with the women. But the argument for why we need to do this is much more complicated than taken at face value. We don't only need women because it is their experiences. We need women because we need a shift in perspective. We need women who can participate as strangers to all that has come before. Feminist arguments have influenced all layers of my argument,

from the participants themselves to the methods of research, because with a feminist perspective the mundane is made strange and the old becomes new. Harding (1991) establishes this need for women involved when she carefully breaks down the concept of strong objectivity, a more specific form of standpoint theory.

Starting thought from women's lives increases the objectivity of the results of research by bringing scientific observation and the perception of the need for explanation to bear on assumptions and practices that appear natural or unremarkable from the perspectives of the lives of men in the dominant groups. Thinking from the perspective of women's lives makes strange what had appeared familiar, which is the beginning of scientific inquiry (p. 150).

Women can provide a very unique standpoint, mostly because of their prior omission. Considering science has historically been done from the perspective of men, women come as non-participants, strangers actually. "Women are valuable 'strangers' to the social order...the stranger can see patterns of belief or behavior that are hard for those immersed in the culture to detect" (Harding, 1991, p. 124). Harding also provides a careful distinction to feminist standpoint theory that carefully differentiated between standpoint and perspective. Women's standpoint and perspective are not interchangeable. It is not just the experiences of women, nor what they say. Standpoint is more than this.

The struggles to end discrimination against women in the sciences enabled people to see that formal discrimination was only the front line of defense against women's equity in scientific fields...Only through such struggles can we begin to see beneath the appearances created by an unjust social order to the reality of how this social order is in fact constructed and maintained. This need for struggle emphasizes the fact that a feminist standpoint is not something that anyone can have by simply claiming it. It is an achievement. A standpoint differs in this respect from a perspective (Harding, p. 127).

This achievement that Harding calls for helps to clarify the differences between standpoint and perspective, because it is easy to assume that any woman can offer their standpoint, as a woman, but Harding would argue that standpoint is more than that. Achievement requires a lot. First, it is a recognition of the forces that are lurking, the societal forces that are unique to women, but also the struggles and survival through these forces. This key to this difference then is participation, because women with a standpoint want to make a difference and they understand the need to share this viewpoint.

One additional note on feminist standpoint is the experiences and interpretations of those experiences. When women deny the presence of gender bias, stereotyping, and exclusionary practices, this does not help us

to move forward. We need women who will not just accept their position:

“...many women in science who make the equity claims do not offer a challenge to the existing social structure or politics of the natural and social sciences. This is a problem” (Harding, 1991, p. 33). Not only is there a problem in the lack of identification or even the denial, but the ultimate goal is to make a difference, and denial does not allow this to happen. “Successful (and unsuccessful) women who said “I’ve never experienced sexism” invariably have done nothing to challenge what was expected of them as women” (Harding, 1991, p. 67). As I will explain later, the ultimate goal in feminist standpoint is the opportunity for social change - the insight to disrupt rather than accept what has been deemed normal. When we take this approach to the sciences, it is not only women who benefit. The recipients are much broader. “Such sciences can and must benefit men, too -- especially those marginalized by racism, imperialism, and class exploitation; the new sciences are not to be *only* for women” (Harding, 1991, p. 5). With the widespread benefits, what are the potential outcomes? Aside from the quantitative outcomes, most important should be the opportunities to make a difference - social justice. The key reason for this work should ultimately point to social justice. Charmaz (2014) provides an in-depth description of what social justice looks like in all stages and what must occur through those processes.

An interest in social justice means attentiveness to ideas and actions concerning fairness, equity, equality, democratic process, status and hierarchy, and individual and collective rights and obligations. It signifies thinking about being human, creating good societies and a better world, and what national and world citizenship means. It involves exploring tensions between complicity and consciousness, choice and constraint, indifference and compassion, inclusion and exclusion, poverty and privilege, and barriers and opportunities. It also means taking a critical stance towards, actions, organizations, and social institutions. Social justice studies require looking at both realities and ideals. Thus, contested meanings of 'shoulds' and 'oughts' come into play. And, unlike positivists of the past, these researchers openly bring their shoulds and oughts into the discourse of inquiry (p. 326).

This list is dense, and overwhelming, but there are key points that must be emphasized in this method towards social justice. In this work, we can carefully uncover that which is lurking, discover, and then once identified, move towards "actions, organizations, and social institutions" with our new approaches and fresh perspectives. Most important is to dig and bring forth these issues into the discourse of inquiry which makes strange what was previously normal.

Grounded Theory

In addition to the feminist framework that guides this research, I have also utilized grounded theory to work through the process and outcomes.

Charmaz (2014) provides this approach, based on the earlier work of Glaser and Strauss, which is a flexible method with qualitative research in which the researcher is not required to establish a theory or strict guidelines, rather the data leads the researcher: "...grounded theory methods consist of systematic, yet flexible guidelines for collecting and analyzing qualitative data to construct theories from the data themselves. Thus, researchers construct a theory 'grounded' in their data" (Charmaz, p. 1). With grounded theory, I did not establish a preconceived direction nor a theory to fit with my data, rather I carefully explored and listened to the data to determine potential theories or directions. Grounded theory was yet another reason to carefully identify my position as the researcher, my role, and my own past to ensure I was aware of how all of that could influence my view and how I interpreted the data.

"Rather, we are part of the world we study, the data we collect, and the analyses we produce. We *construct* our grounded theories through our past and present involvements and interactions with people, perspectives, and research practices" (Charmaz, p. 17). I cannot stress enough in the approach that I am taking the importance of recognizing my own biases and viewpoints to be utterly aware of how that may come into play. In my interpretation of the data, I must utilize a perspective in which I try to eliminate expectations based on those experiences, rather to look at the data with clarity to

determine how to proceed. In later sections, I will discuss how I made decisions during the research process based on what I gained from my initial research. Though I had a plan to begin, I did not limit myself by adhering to this plan, but rather allowed for flexibility, change in direction, and new ideas to lead me as continually gleaned from the data and the experience.

QUALITATIVE RESEARCH METHODS: USING IN-DEPTH INTERVIEWS

As was established in the previous chapter, co-op research has evolved and grown over its lifetime, and clear trends have emerged throughout. At this moment, women are one population that have yet to be adequately covered, with gender being but a small detail. But in addition to the focus on women, this research requires a fresh approach and a new perspective. For this study, a feminist framework also requires qualitative methods (in-depth interviews) to provide opportunities for these women to share their own stories and experiences. The in-depth interviews I conducted with the women provided an opportunity for them to share their stories, giving a space for not only their perspectives, but also their standpoint. Quantitative measurements cannot capture the struggles and achievements they experienced in their day to day existence at their worksites. Through interviews, there is the freedom and space to share what happened, but even more important are the how's, why's, and so what's. The interviews then are the best method of research to capture the level of detail that is necessary in getting to an understanding of how those social orders are maintained.

Cooperative Education has the lengthy history and presence because of the benefits gained from this type of learning experience. Early research on the benefits of co-op tended to focus on the tangible results that could be easily quantitatively measured. The easiest unit of measurement were to look at salaries of full time employment after graduation and compare those with co-op experience, to those who had not. As established in the previous chapter, retention and GPA were also highly researched quantitative measurements. Measureable, comparable, quantitative statistics are tangible numbers and evidence that speaks well to administrators, parents, and even educational policy. It provides evidence of benefits that are constantly being used to measure the value of a university or even a program - like placement and retention. These types of research studies and data sets do not represent the entirety of co-op research, but have made up a lot of what has been done. However, there is more to learn than what quantitative studies can offer. Those methods do not allow us to understand the realities for women and opportunities to disrupt systems or even recognize the uncovered assumptions and biases. Regardless of the method, it is crucial to recognize no method is objective or impartial. As Kirsch (1992) established, "...all methodologies are culturally situated and inscribed, never disinterested or impartial" (p. 248). With the plethora of quantitative studies that make up co-op research, what are the cultural implications and limitations that prevent

co-op research to move forward? Have we really evolved much beyond the original co-op model and the originally established benefits?

Qualitative research then provides a different look at the co-op experience that is impossible to gain from strictly quantitative methods. But even qualitative is not adequate if it is not done thoughtfully, recognizing both the researcher's position and the exercise of thoughtful listening. "Listening carefully to different voices and attending thoughtfully to others' values and interests can enlarge our vision and begin to correct for inevitable ethnocentrism. (The dominant values, interests, and voices are not among these 'different' ones; they are the powerful tide against which 'difference' must swim)" (Harding, 1991, p. 152). Qualitative research has the potential for a richness that is otherwise impossible, but this is also not possible without the careful listening and an approach by the researcher in which the goal is to broaden the vision and see beyond dominant values, interests and voices.

In speaking with the women through interviews, my goal was to capture their experiences as women in engineering, their learning on co-op, and the overall impact the co-op had on their identities and long-term plans. Without asking these questions, providing space to answer, and careful listening, I would be unable to gather a detailed account. This was why Weiss (1994)

called for interviews in qualitative research. Through interviews we get the "full story we want and not simply answers to standardized questions" (p. 3). In Weiss' argument for qualitative data over quantitative data, he offers seven reasons for qualitative research: 1) developing detailed descriptions; 2) integrating multiple perspectives; 3) describing process; 4) developing holistic description; 5) learning how events are interpreted; 6) bridging inter subjectivities, and; 7) identifying variables and framing hypothesis for qualitative research. (p. 3) Numbers alone are not able to provide all of these insights that are possible from a qualitative study. The women gave detailed descriptions of scenarios. I heard different stories that came through their multiple perspectives as female engineers in different companies within different departments, yet I also recognized the inter-subjectivities that emerged. I had a much more holistic view, a view that is impossible with numbers. There is richness in the stories the women told. Linn (2012) asks, "can stories be data," and points to Miles and Huberman (1994). "Words are fatter than numbers and usually have multiple meanings" (p. 56)." Without hearing the stories and experiences of the students while on co-op, there will be very little insight into their experience, because while we can capture the results of quantifiable outcomes with numbers, we are no closer to understanding how and why. In Linn's work, "the combination of qualitative and quantitative methods seems to have the potential to capture both the commonalities across students' experiences and the unique quality of each

student's co-op learning" (Linn, p. 111). Bryman (2006) offers some insight into the mixed methods approach, and while some may still argue against it, his point regarding the element of surprise in qualitative data is exactly why the interviews were so valuable. "Qualitative research is often pictured as a research strategy whose emphasis on a relatively open-ended approach to the research process frequently produces surprises, changes of direction, and new insights" (p. 111). When I sat and listened to their stories, there were clear changes of direction and new insights that are impossible to uncover with only the numbers.

As part of the research, the quantitative data from the Likert-Scale surveys provide additional information on all undergraduate co-op students, both men and women from all majors. This data provides insight into the overall experience of Michigan Tech students and a measurement of which to compare the experience and results of the women interviewed. These insights will provide a larger context from which to view the co-op experience, but additionally an opportunity in which to compare the overall cohort to the women.

Interviews as Constructions and Performance

Considering so much focus is on the interviews with the women, it is worth noting that there are critics of interviews, so I will acknowledge those here. One criticism of interviews is because they provide opportunities to

reconstruct what actually happened. “A number of criticisms and those who follow them turn on notions of accuracy. Interviews consist of retrospective narratives. What people say may not be what they do, have done, and would do in the future. Interviews are performances that research participants give for a particular purpose” (Charmaz, 2014, p. 78). Considering the power and authority between the students and myself, I think these interviews could very well be a type of performance, but this does not discontinue them, nor lessen their value. Even as performances, the participants were able to share aspects of their experience.

Whether participants recount their concerns without interruption or researchers request specific information, the result is a construction - or reconstruction - of a reality. Through constructing their respective performances, interviewers and interview participants present themselves to each other. However silently, both the interviewer and the participants’ performances make and negotiate identity claims (Charmaz, p. 79).

Might they have talked differently if a different audience? Perhaps, but we all make rhetorical decisions each time we write or speak with someone, and this does not mean there are no messages shared. As I asked the questions, I was very aware of this performance, especially because of my own position. As a professional staff member, I too felt that I had to display my identity as such. It is difficult to determine how the interview may have

been different had I not selected this identity, but I need to acknowledge that it was at play. As for the students, at times I believe their responses were in alignment with what they felt I wanted them to say, or portions of their experience that allowed them to showcase their accomplishments. However, I do not believe it swayed them enough to erase the significance of their accounts.

DETAILS OF THE CO-OP RESEARCH STUDY AT MICHIGAN TECH

Students enrolled in Cooperative Education at Michigan Tech during the spring 2016 semester were asked to voluntarily participate in a study to better understand their co-op experience and ultimately, provide valuable information, insight and feedback to improve the university co-op program and the experiences for future students. This project was IRB approved in November 2015, with an extension granted in November 2016. The study consists of a pre-survey, post-survey, and in-depth interviews. The pre-survey was given to the co-op students prior to the start of their spring 2016 semester. The first round was done at the *Career Services Mandatory Co-op Meeting*, with hardcopy surveys and IRB consent forms. Because not all of the participants were present at the meeting, some completed the survey online at a later date. Overall, 116 students completed the pre-survey. Those who completed the survey included both undergraduate and graduate students, domestic and international, with no restriction on major. The results that will be included in this study will only include the undergraduate students

who participated in the survey, because the needs and results of the graduate students, especially because the majority are international students, are very different. Thus, to ensure a consistency amongst participants and focus on the issues at hand, the survey results were filtered to include only undergraduate students, with no restriction in major. Being the interviews were done with a subset of female co-op students, I have also included the survey results for the undergraduate female cohort. Comparing the survey results of these two groups provides some comparison as to the quantitative results of the overall co-op cohort as compared to the female cohort.

Table 3.1 Number of Participants in the Pre- and Post-Surveys

Pre-Survey Overall Undergraduate Cohort	89
Post-Survey Overall Undergraduate Cohort	45
Pre-Survey Female Undergraduate Cohort	24
Post-Survey Female Undergraduate Cohort	15

The goal of the surveys was to measure the pre co-op and post co-op levels of confidence, as well as gathering overall outcomes of the co-op experience and the methods for learning. The survey categories were set up in conjunction with Raelin et al (2011, 2014) as his work has quantitatively measured levels of academic, work, and career self-efficacy. Raelin's work provided the overarching structure and categories for the pre- and post-

surveys. But within those three categories, I have used two additional frameworks with which to identify and define the subcategories.

For *Academic Self-Efficacy*, which includes technical skills, I relied on an institutional framework in order to ensure consistency amongst the students. Cooperative education at Michigan Tech is available to students in all majors, but the majority of students who participate in the program are engineering majors due to the demand for co-op students in the engineering fields. Considering the variety of majors, even within engineering, it is near impossible to quantitatively capture the academic-related learning that occurs during a co-op without a framework consistent amongst all students in this study. For this I turned to Michigan Tech's *Undergraduate Student Learning Goals* to provide for that consistency. Using these goals provides academic categories, important to the university, which in turn shows the effectiveness of cooperative education's contribution towards the university's academic learning goals. As stated on the university's website, "These goals are achieved by student engagement in learning opportunities across the university -- in the general education program, the degree programs, and student affairs programs" (Michigan Tech Assessment: University Goals and Rubrics). Thus, cooperative education clearly fits as one of these learning opportunities across campus, and meets the requirements for how the university expects the students will achieve these goals. For these reasons,

these goals provided the consistency and framework necessary for this research and a valid method for quantitatively capturing the students' levels of confidence in their academics.

For *Work Self-Efficacy* (professional skills) and *Career Self-Efficacy* (career development skills), the National Association for Colleges and Employers (NACE) has developed a list of Career Competencies defining the skills necessary for a student to transition from school to work. "Definition of Career Readiness and Competencies: Career readiness is the attainment and demonstration of requisite competencies that broadly prepare college graduates for a successful transition into the workplace" (NACE Career Readiness Defined). As a national organization, NACE sets the standards for university career services and employers nationwide, so those in the field would be most interested in research that can address methods and their effectiveness for reaching these competencies. Both professional and career development skills can quickly turn into an unruly list of skills, so these NACE guidelines kept the sub-categories to a manageable size, focusing on the most pertinent in preparing a student for the workplace. Overall, the goal was to ensure that each subcategory was tied to at least one of these larger frameworks.

Table 3.2 Cooperative Education Survey Categories: Including the Michigan Tech Student Learning Goals and the NACE Career Competencies

Survey Categories	Survey Sub-Categories	University Student Learning Goals	NACE Career Competencies
Academic Self-Efficacy (including Technical Skills)			
	Disciplinary Knowledge	Disciplinary Knowledge	
	Knowledge of the Physical and Natural World	Knowledge of the Physical and Natural World	
	Global Literacy	Global Literacy	
	Critical and Creative Thinking	Critical and Creative Thinking	Critical Thinking and Problem Solving
	Communication	Communication	Oral and Written Communication
	Information Literacy	Information Literacy	Information Literacy Application
	Technology	Technology	
	Social and Ethical Responsibility	Social and Ethical Responsibility	
Work Self-Efficacy (Professional Skills)			
	Professional Communication		Oral and Written Communication
	Effective Teamwork		Teamwork and Collaboration
	Problem Solving		Critical Thinking and Problem Solving
	Initiative		Professionalism and Worth Ethic

Career Self-Efficacy (Career Development Skills)			
	Effective and Targeted Job Search		Career Management
	Strong Professional Resume		Career Management
	Identifying and Setting Career Goals		Career Management
	Determining Best Fit for Company and Position		Career Management

The pre- and post-surveys were set up by three main categories, Academic, Work, and Career, with the goal of capturing the students starting levels and change in confidence as a result of the co-op experience. The pre- and post-surveys were near replicas of one another, with slight differences in the post-survey to capture co-op outcomes and the overall experience. In both surveys, the three main categories were set up as the first three sections of the survey. Within each section, there were statements related to academic and technical knowledge, work and professional skills, and career development skills. Prior to asking about the specific skills, there were general questions that addressed the students' agreement with statements regarding their preparation and expectations. In the academic section, the first two questions asked whether they felt there was connection between their coursework and the co-op and whether their coursework had prepared them for the co-op. The skill section then asked the students to identify their

level of confidence. Each question in the academic section included information on the source of the academic skills and a definition, per the university learning goals. “NOTE: The following list is Michigan Tech University Student Learning Goals. Definitions, as provided by the university, have been included. - *Global Literacy*: Demonstrate the ability to understand and analyze issues on multiple scales and from diverse perspectives.” The options were then a Likert-scale: extremely confident, very confident, moderately confident, slightly confident, not at all confident, and not sure/not applicable. This same format was used for the Work and Career sections, using the subcategories listed in Table 3.2. In those sections, the opening questions asked about the students’ understanding of work expectations and professional requirements, and finally their plans for their academic degree and career.

The final section of the pre-survey collected demographic data to later analyze the data by group. Data collected was year in school, major, domestic or international, gender, age, and previous co-op/internship experience. In the post-survey, there was a slight change of language to reflect the results of co-op. Rather than, *I see a direct connection between what I am learning in the classroom to what I will be doing in my co-op work*, the post-survey instead asked, *I see a direct connection between what I learned in the classroom to what I did in my co-op work*. These changes

were made for all of the opening questions. At the conclusion of each section in the post-survey, three additional questions were added to determine whether they had gained academic/work/career skills as a result of their co-op, plus which skills and the learning methods utilized. In the post-survey, a final section was added to assess the overall benefits and outcomes of the overall co-op experience - the most and least beneficial outcomes and the programs offered by the company of which they had participated.

The Interview Participants

All of the undergraduate women who participated in the university co-op program during the spring 2016 semester were invited for the interview portion of the study. Conducting interviews with females was purposeful in exploring the realities of their lives as female engineers in the workplace. Women made up 28% of the semester's co-op population, an exact match to our institution's gender ratio. From the pool of women on co-op (27), 41% (11 women) agreed to participate in the interview portion of the study. All but one of the women were in the College of Engineering and worked in positions that were related to their major. The first round of interviews took place in summer 2016, with the second round done in November/December 2016. The women were selected for the second interview based on the richness and detail provided in their initial interview, and the follow up questions were crafted to gain additional information about topics that arose during their first interview. The interviews for the first round were done by

phone, with the exception of one emailed interview. Second round interviews were all done face to face.

The women interviewed had a variety of class standings, engineering majors, and previous co-op and internship experiences. One additional detail were the start and end dates of their spring co-ops. They were all working as co-op students during the spring 2016 semester, but for some it was the first, or only semester of work, and others had already been working for a semester or more. In the interviews, the women spoke of their experience as a whole, as they could not differentiate what happened during a certain semester.

They looked at the entire experience, because when they were interviewed in the summer, their co-op had either ended or they were nearing the end of the co-op, so it provided an opportunity for a more holistic reflection on the entire co-op experience.

Table 3.3 Female Interview Participants

	Interview 1	Interview 2
Total number of women	11	5
Number of women with previous co-op / internship experience	5	3
Second or Third Year Standing	7	3
Fourth or Fifth Year Standing	4	2

The second round of interviews were then done with five of those women who offered the most richness and detail. For those five women, plus one woman with whom I had an email interview, I will provide pseudonyms and profiles for each. These women were the most significant contributors to this study, and I have clustered them to indicate particular patterns in their co-op experiences.

In the first interview, I used the same set of questions for all of the women focusing on overall experience and significant events - company culture, mentors, gender, challenges, learning outcomes, self-awareness, and personal change. Considering my framework in grounded theory, an effective method is to begin with broad open-ended questions. I used the same set of broad questions, in the same order, for each of the interviews. This process allowed me to compare the responses between participants, which provided rich data from which to compare the effects of certain aspects of the co-op. In the second round of interviews, I analyzed the results of the first round and identified eight themes that were worth more fully exploring, as they related to this study.

- Bringing the Co-op Back to Campus
- The People
- Experience Beyond the Classroom
- Life as a Female Engineer

- The Significance of Co-op
- Identity
- Preparing for the Workplace
- Mentors and Role Models

In the second round of interviews, I was cognizant of the goal set by a grounded theory approach, which allowed me to set up topics based on the first interviews. “The iterative process of grounded theory often brings researchers back to research participants whom they have already interviewed. Alternatively, we include new lines of inquiry in later interviews that reflect our developing analyses” (Charmaz, 2014, p. 103). The second round allowed me to follow up on the responses that showed potential for depth, insight into the established themes, and even new ideas. In addition, I was careful not to feel that I had to stick so closely to the questions in round 2, but rather allow the participants to guide the discussion. With those themes, it then provided less structure and more opportunity to allow the women an opportunity to talk. I felt less tied to my script, as compared to the first round.

Both rounds of interviews were under time constraints due to the participants’ schedules. For round 1, most were currently working, either in their co-op or a summer internship or job. For this reason, they were limited to a lunch hour, so as the interviewer I had to be respectful of their time. In the second

round the participants were back on campus, but it was week 13 in the semester after Thanksgiving break. Historically, this is a very busy and stressful time due to exams, end of semester assignments and projects, and the upcoming finals. Again, I wanted to be respectful of their time, so I asked for 30 minutes, and with a few exceptions we stayed within those time frames. Charmaz makes this note on time: "Placing arbitrary limits on the length of an interview, can, however, negate researchers' best intentions. Arbitrary time limits can stifle a story or curtail possibilities for analytic exploration" (p. 86). If I had the option, I would have eliminated the time limit, but they were necessary due to the participants' responsibilities and their own limits. I was able to get these volunteers from a larger pool, and I didn't want them to make a commitment that would have affected their other obligations. Thus, time was an issue.

Constructing Codes

In my role as the researcher and interviewer, the research is collected and analyzed by me, meaning that I am bringing myself into it, regardless of how hard I may try not to - it is an impossible to leave myself out. When I analyzed the in-depth interviews, determined codes, and identified patterns and areas to focus on, this was my view. Charmaz (2014) acknowledges the researcher's role, even within the process of coding.

We construct our codes because we are actively naming data - even when we believe our codes form a perfect fit with actions and events

in the studied world. We may think our codes capture the empirical reality, yet it is *our* view: we choose the words that constitute our codes. Thus we define what we see as significant in the data and describe what we think is happening...We interact with our participants and subsequently interact with them again many times over through studying their statements and observed actions and re-envisioning the scenes in which we know them” (p. 115).

After the first round of interviews, I did not determine the codes nor my focus until I had stepped back and read the transcripts with fresh eyes. There was one interview in particular, Anna, that was extremely detailed and included many different components of her co-op, so I used that interview as a guide to compile my first set of codes. This provided a guideline in coding the other interviews, yet I also wasn't confined to only those codes. I began with a comprehensive list of codes that addressed each significant point. In addition, I coded one of the questions separately in order to compare how each woman answered the question: *Tell me about your co-op experience*. I wanted to review these separately to identify what types of details were included and left out, and why each woman answered with such detail or brevity.

I was continually confident in my methods based on grounded theory because it provided flexibility, but also the relief that I could not make a

mistake by missing something. Rather, with reflection and analysis, I would find gaps and then propose methods in which to fill them. “Initial grounded theory coding can prompt you to see areas in which you lack needed data. Realizing your data may have gaps -- or holes -- is part of the analytic process” (Charmaz, p. 118). For the second round of interviews, as mentioned I was using them to follow up on certain parts of the first interviews to gain more information, as well as asking questions that were more focused, having determined where the research was going. While the questions were focused mostly on some of the codes from Interview 1, there were a few additional codes I added from the second round of interviews.

Table 3.4 Comprehensive List of Codes for Interviews 1 & 2

Best practices	Professional Goals
Career Skills	Professional Skills
Co-op Benefits	Projects <ul style="list-style-type: none"> • Process • Results
Discourses and Communities of Practice	Narratives
Diversity	Network
Identity <ul style="list-style-type: none"> • Gender • Engineer • Hierarchy • Superiority 	Relationships
Leadership	Transition from Co-op to Class
Learning Methods	Workplace Culture
Managers and Mentors	

Once I had coded the interviews and determined which areas I would focus on for this study, I then compiled all of the responses for each of pertinent codes. This was a fruitful step in the process because I was able to get a comprehensive overview of all of the responses within that code, and this is where those themes and patterns were even more evident. While I was unable to respond to all that I found from the in-depth interviews in this study, I plan to continue my analysis of the data for future use.

CONCLUSION

The women interviewed were participants in their workplaces, and their perspective allows us to examine the everyday, the mundane, and the realities to make them unfamiliar and strange, ultimately moving us toward creating a space that is more inclusive. These women are experiencing life as a female engineer, thus, they do not know any alternative. As the researcher, I needed to approach these interviews and the data collected with a keen sense of my own interests and background, working to leave these behind in order to see clearly. “Let the world appear anew through your data...Rich data are detailed, focused, and full. They reveal participants’ views, feelings, intentions, and actions as well as the contexts and structures of their lives” (Charmaz, 2014, p. 23) The only way we can see the world and interpret our experiences is from our own unique position. Every standpoint is unique, so much in fact that no two people will share the same standpoint.

Without asking about their experiences, it is near impossible to truly understand their experience, how it may differ from that of a male co-op, and why those differences matter. Though simple, this mindset of asking and listening truly comes from the feminist perspective that I propose which allows me to look at something old and try to provide a new and fresh perspective. The framework and methods proposed in this chapter have established how to see co-op with a new lens, establish my role and responsibilities as a researcher, and then use the data in an organic way so as not to feel constrained, but rather break the boundaries and restrictions that have previously limited co-op research on women.

Key Insights into the Co-op Experience for Female Engineers: Focusing on Self-Efficacy, Gender, and Identity Outcomes

Because cooperative education has the opportunity to respond to societal needs, I have focused this research on women in engineering in order to contribute to the efforts of increasing their recruitment and retention. Unlike a lot of the co-op research, my methods included both quantitative and qualitative methods in order to more fully understand the women's experience in a male-dominated workplace. While earlier quantitative measurements have shown the differences for men versus women on co-op are minimal, I was unsatisfied with those results, knowing the highly imbalanced ratios of male versus female engineers. Thus, I wanted to learn the rest of the story, and not from their supervisors or co-op professionals, but from the women themselves. The results presented here were collected through both quantitative (pre- and post-surveys) and qualitative (interviews) methods and together provide a holistic account of the outcomes of cooperative education, with additional details from the interviews providing the data necessary to understand how and why these outcomes occurred. The results have been categorized by overarching themes, and within each section, I will review the quantitative results of the surveys, but also include the qualitative data from the interviews. By intertwining the quantitative and qualitative results, I am able to show the trends of the entire group, but then

provide the more personal accounts that were given by the women, and how their experiences and perspectives, while similar, have unique qualities that are worthy of our attention. The inclusion of the women's voices, the stories they tell, and the feminist methods in obtaining and analyzing the data offers a less common approach to cooperative education research. This ensures a freedom from following a prescribed status or formula to be followed, but instead the opportunity for the data to speak, without expectation or assumptions in what it must say.

This chapter will present both sets of data, as I have mentioned, and through those data I will report findings, identify patterns, and identify questions that will lead to the final chapter. What I will not do in this chapter is a theoretical analysis, but instead I have saved this discussion for chapter 5. There are themes that very much speak to the theorists I have introduced in both chapters 2 and 3, and I will respond to how the results have aligned with those theorists in the next chapter, in addition to presenting a theoretical model for female co-op engineers.

Meet a Few of the Women

Before presenting the results, I first want to introduce the six women I mentioned in the methods. Each of the women have been given a pseudonym and I have included a short profile to provide her a persona and an opportunity for the reader to follow her throughout the journey.

Anna: Mechanical Engineer, Junior, Test and Development Co-op

“Test engineer for the test and development of military vehicles”

Anna returned to her co-op site after having worked in another department the previous summer. This was her third co-op/internship experience, and she completed her fourth immediately after her spring co-op.

Emilia: Electrical Engineer, Junior, Oil Industry Co-op

“Electrical and instrumentation group, instrumentation mainly... doing small capital projects (under \$50,000)”

Emilia’s co-op was only one semester, and it was also her first. At the conclusion of the spring semester, she began a summer internship.

Veera: Civil Engineer, Senior, Pipeline Industry Co-op

“Primary project manager for asphalt management projects...leading the U.S. roll”

Veera had a 16-month co-op with her company, so the spring semester was the last four months of that co-op. At the conclusion of spring, she began a summer internship, and graduated in December 2016. At the time of the second interview, she had accepted a full time offer.

lida: Chemical Engineer, Junior, Paper Company Co-op

“Worked on a few trial chemicals to put on the paper machines...and leadership work in the paper unit”

lida also had a 16-month co-op with her company, and was completing her final four months. Prior to that experience, she had an internship during the summer between high school and college. Though a third year, she did transfer so she will have an three additional years on campus, with plans to either complete a study abroad or obtain a research position during her time remaining.

Sara: Electrical Engineer, Senior, Commercial Laundry Systems Co-op

“One of my biggest projects has been mainly focused on data analysis”

Sara was in her first semester of a two-semester co-op, but had completed an internship previously. She graduated in April 2017, and at the time of the second interview, she had accepted a full time offer.

Jenni: Electrical Engineer, Senior, Consumer Care Products Co-op

“Electrical engineering team...broad view of industrial engineering...[projects] very long and included sometimes several learning curves”

Jenni was in her first co-op, the first semester of a two-semester position.

She was the only woman whom I did not meet with face to face, but instead conducted the interview by email during round one.

By providing more information on these six particular women, it should give a more holistic account of their stories and experiences. For the other women, I have included their voices to illustrate explanations and details within the themes, but to name them would have made it difficult to track all 11 women.

The Women's Work

As engineering majors, all of the women were hired to do the work of engineers (with the exception of one - Business Management Supply Chain Operation - but she worked with a lot of engineers in her position). There can be some misconception about the work an intern or co-op performs at their worksite, as some are delegated to paper pushing, filing, and other menial tasks. However, this is rarely the case for Michigan Tech co-op students, and this group of women was no exception. Quantitatively, one woman provided the worth of her project: she was "managing probably four to five million dollars worth of work." While not everyone was able to put a price tag on their work, they were all assigned projects that would be used in some capacity by the company. It is important to note that these were also not projects to keep them busy, but rather products and systems the companies needed and valued. Despite the differences in the lengths of the co-ops, they were most pleased with their participation in the projects from beginning to end. During some internships especially, the short length of time only allows students to work on part of a project. But typically, a co-op is longer, thus allowing the students to participate in their project from beginning to end. Being a part of

that entire process was mentioned by many of the women. “And because I had those co-op opportunities, I was able to really, you know, make it my own instead of doing a little part and then having to hand it off.” One of Emilia’s projects had just been installed prior to the first interview and her co-workers had sent pictures so she could see the physical installation.

All 11 women were also involved in work that was new to them; regardless of their year in school or number of semesters in that particular major, the context-specific projects and tasks they were assigned were not replicas to the knowledge they were bringing from the classroom. One said she was doing things “she had never done before in my EE classes.” While they had adequate background knowledge, most learned things that were completely new. One said, “I learned a lot very quickly, so I ended up working on a lot of different projects.” And yet another recognized a significant shift in her learning from theory to practice: “I didn’t really have any experience with hands-on at all. I basically learned how to complete a project as an engineer.” One woman’s project was not only something she hadn’t done, but also a process that had never been done at her company. She was creating something with no prerequisite or established procedures. As shown, their experiences were new to them all, but in different ways. One detail regarding previous experience was the difference in co-op and internship experience between the overall cohort and the female cohort. In

the pre-survey, a higher percentage of the women had co-op experience, and in both surveys, the percentage of women with previous internship experience was significantly higher than the overall cohort. For the women interviewed, 45% (5) had previous co-op and/or internship experience prior to the spring semester.

As significant as the projects themselves were the responsibilities that accompanied those projects, especially when the women were also in a project management role. Three women were specifically given this title or role with supervisory and/or project management responsibilities, while others were independently responsible for managing their own projects and all that entailed. “Definitely as I’ve been here, I’ve been given more responsibility and less supervision.” Though the size and scope of those responsibilities varied, some of the women had significant responsibilities as the leader. “I mean if my title wasn’t intern, it probably would have been along the lines of like, assistant project manager.” In the classroom, the context is so different that there is not the freedom to make decisions and create something without the structure of assignment requirements and specific expectations. A lot of that structure is gone in the workplace, so these women were truly making decisions at each step of the way. One project leader was able to “take a product from the idea and bring it to market.” The outcomes of a co-op are far different than an assignment or

project in the classroom. They were seeing how their work was actually used in industry.

THE RESULTS IN ACADEMIC, WORK, AND CAREER SELF-EFFICACY

In this section, I present the results from both the pre- and post-surveys.

They are organized within the three overarching categories - academic, work, and career. Within each section, I present all of the quantitative survey data in the tables, but my analysis will focus only on those results that were most numerically significant (+ / - 20% or more). After a brief summary of the quantitative results, I will move into a discussion with more detailed insights from the interview data in order to better understand the numbers. This allows us to move from speculation about the numbers to the results gained from the interviews. After I have presented the quantitative data and the related interview data, I will then move into additional interview results organized by key themes: leadership, gender, identity, and mentors.

Academic Self-Efficacy: academic and technical skills

In the table below, I have presented the Academic Self-Efficacy survey results. Rather than including all of the data, I have included only those responses in which the students choose *Extremely Confident* or *Very Confident*. For those questions where the other Likert-scale options provided relevant data, I will include those results in the description.

Table 4.1 Academic Self-Efficacy Survey Results: Percentage of Extremely Confident or Very Confident Responses

	Overall Pre-Survey	Female Pre-Survey	Overall Post-Survey	Female Post-Survey	Overall Change Female Change
Disciplinary Knowledge (DK)	52%	42%	80%	80%	+28% +38%
Knowledge of the Physical and Natural World (KPNW)	71%	58%	80%	67%	+9% +9%
Global Literacy (GL)	57%	51%	73%	60%	+16% +9%
Critical and Creative Thinking (CCT)	71%	67%	91%	86%	+20% +19%
Communication	74%	67%	84%	87%	+10% +20%
Information Literacy (IL)	73%	66%	78%	74%	+5% +8%
Technology	80%	67%	84%	60%	+4% -7%
Social and Ethical Responsibility (USLG)	79%	80%	84%	80%	+5% +/-0%

Disciplinary Knowledge (DK) refers to the academic course content that is most relevant to the students' majors. The measurement of confidence in *DK* produced two significant results that should be given attention. First, the pre-survey level of confidence for the female cohort was quite low overall, only 42% felt extremely or very confident in their disciplinary knowledge,

compared to 52% of the overall cohort. These women, as compared to all of the co-op students, had less confidence in their academic, major-specific knowledge. What is promising is that while the starting levels may have been low, the increase in the women's confidence was one of the largest throughout the entire survey (+38%). So while women may be less confident in their major to begin, a co-op semester may provide a significant increase to their level of confidence in this category.

I will briefly comment on *Critical and Creative Thinking (CCT)* because the overall cohort had a +20% shift, and the female cohort increased by +19%. Thus, this is an area that may see a significant positive shift as a result of the co-op experience. For *Communication*, women were less confident to begin, but their growth in confidence was double that of the overall results (+20% compared to +10%), and a higher percentage of the female cohort was more confident in the post-survey (87% versus 84%). Communication is the only category within Academic Self-Efficacy where the females were more confident than the overall in the post-survey results.

Table 4.2 Connections between Classroom and Co-op: Percentage of Strongly Agree and Moderately Agree

	Overall Pre-Survey	Female Pre-Survey	Overall Post-Survey	Female Post-Survey	Overall Change Female Change

I see a direct connection between learning in classroom to co-op work ¹	80%	88%	71%	86%	-9% -2%
My coursework prepared me for my co-op	80%	80%	73%	87%	-7% +7%
I gained technical knowledge/skills related to my field of study			95%	100%	

When asked about the connection and preparation their classroom experience provided in co-op preparation, the overall cohort had predicted a greater connection prior to the co-op, but after the semester felt there was less clear of a connection between their classroom knowledge and their co-op work. Thus, they were expecting the co-op to be more directly related to their coursework than it was. The shift was most apparent in those students who disagreed with the statement in the post-survey: 14% more students disagreed that there was a connection between the classroom and co-op work. Whereas, there was little change in perspective for the female cohort.

¹ *Overall cohort post-survey +14% who moderately or strongly disagreed (from 1% to 15% who disagreed with the statement)

This trend may be better understood by the results of the interview when the women were asked to describe the differences between classroom learning and co-op learning. The women said the workplace content was very different and there was a lot less of the classroom knowledge utilized in the co-op than they would have predicted. On the job, the women were able to recognize some of the theory and math they had gained from coursework, but more importantly saw how that was translated into an actual engineering project. In describing the differences between a course exam or assignment, as compared to a work project, one woman described the holistic view of the project. "On the job you just see it come together." Another described her own learning style to be a better match with the learning that occurred on her co-op compared to the classroom: "In general I'm a very hands-on learner. When I see things, when I see things happen it really clicks for me. So I feel like I learned a lot." For her, the classroom didn't provide enough, if any, opportunities to see things happen, so the co-op was a more effective learning method for her. None of the 11 women described the two contexts for learning as similar, with the exception of one woman's mentor who provided her lessons on his whiteboard. Otherwise, all 11 described two distinctly different types of learning and content. This then shows why perhaps the cohorts saw less of a connection between their classroom preparation and knowledge and the actual work they performed on co-op.

Work Self-Efficacy: professional skills

Work self-efficacy refers to those skills required in the workplace, otherwise known as professional skills or soft skills. There are a multitude of lists available to use in identifying professional skills, but I have limited those skills to just four, considering the Michigan Tech University Student Learning Goals and the NACE Career Competencies.

In the table below, I have presented the *Work Self-Efficacy* survey results. Rather than including all of the data, I have included only those responses in which the students choose *Extremely Confident* or *Very Confident*. For those questions where the other Likert-scale options provided relevant data, I will include those results in the description.

Table 4.3 Work Self-Efficacy Survey Results: Percentage of *Extremely Confident* or *Very Confident* Responses

	Overall Pre	Female Pre	Overall Post	Female Post	Overall Diff Female Diff
Professional Communication	67%	54%	91%	86%	+24% +32%
Effective Teamwork	91%	83%	96%	100%	+5% +17%
Problem Solving	82%	58%	93%	87%	+11% +29%
Initiative	79%	67%	88%	80%	+9% +13%

Though communication has already appeared in the survey, it was necessary to include *Professional Communication*, defined differently than the *Academic Self-Efficacy: Communication*. In the *Academic* section, communication was defined by the university learning goals: “Students will be able to communicate effectively, orally, in writing and in new media, to a wide variety of audiences” (Assessment: University Goals and Rubrics). Based on this definition, it is clear that these types of written and oral communication are more directly tied to the general education courses and requirements. Whereas, *Professional Communication* in this section was defined as “Oral and written communication for a professional purpose; including but not limited to professional email, professional reports, presentations, etc.” Thus, the two types of communication have significant enough differences to include both.

In the results for professional communication, similar to the results in the *Academic* section, the female cohort began with a lower level of confidence in their *Professional Communication*. However, the increase in confidence for the cohort was the second largest in the survey (+32%), with only *Disciplinary Knowledge* having been larger. While engineering students may be stereotyped as poor communicators, once they enter the workplace reality sets in and the importance of effective communication is evident. The survey cannot verify why both cohorts began with their lowest levels of confidence in all work categories having been *Professional Communication*, but stereotypes like this may have been one reason, as explained by one of the

women. "Communication is the biggest thing in the workforce. As much as people say that engineers are horrible at communicating. I don't know where they're getting that information, but I feel to be a good engineer you have to be able to communicate because that's all we do." Thus, cooperative education is not only beneficial in gaining technical skills, but also communication, especially in positively influencing their self-confidence in professional workplace communication.

The women were able to share their stories of how they improved in their communication and the results of gaining communication skills. This theme emerged as all 11 women spoke of the necessity of communication in the workplace, but four women very specifically spoke on the skill of asking questions with clarity in order to gain the knowledge necessary for a specific task or project. Sara was very forthcoming in explaining her frustrations, but also the process she went through to try and improve the communication she was having when faced with a new project.

I was frustrated that I wasn't able to understand what he was saying and I felt like I kept trying to ask a different question, but it took time for me to learn how to communicate effectively with him...I really realized that people need information delivered in different ways. And so I learned how to figure out what questions each person would ask me when I would approach them with a problem...it made things go a

lot smoother and easier and I felt like each engineer valued what I had to say more often.

The women were able to clearly explain the problems they were experiencing with the communication at the worksite, but also described how they had derived clear strategies through work and practice. One woman broke down her effective communication process into steps. “If you’re not communicating clearly, try and reevaluate, get more knowledge, and make sure you know exactly what you are saying so that other people can understand what you’re saying.” This need to constantly scrutinize their own communication and then the opportunity to work with so many people at their worksites provided ample practice for authentic workplace communication. Though it could have been easy to become frustrated or blame others for the breakdown in communication, this woman did not do either, but rather pinpointed her own problem. “Sometimes I would ask a question and people didn’t understand exactly what I was asking. So it was a big learning curve on how do I put context behind what I am talking about and rephrase them so that people can understand.” During their experience, these women quickly realized, if they had not already, that communication as an engineer was a crucial skill and one that would make or break their success. This insight allows us to better understand why the women’s increase in confidence on the survey was quantitatively significant.

Another significant numerical result was the female cohort's positive shift in problem solving. Only second lowest to professional communication, the post-survey results showed a +29% change. When the women in the interviews spoke of learning, collaboration, and project challenges, these all pointed to types of problem solving. While it can come in many forms, Anna had one project that she knew from the start would be difficult. Her supervisor called her in and offered her a chance to take it on, acknowledging it would be tough. The challenges included components of the project itself, having to reserve a significant amount of equipment and work her plans around others' reservations, a tight schedule, and a lot of snow, resulting in her shoveling an airport runway at 5:30 a.m. Anna knew she had to get the job done, regardless of the circumstances, including the weather. Throughout this one project, and she had many, she overcame a multitude of issues using her tenacity and problem solving. Once these women were able to see their accomplishments and their abilities to problem solve through them, it is clear why this number increased.

Table 4.4 Understanding and Meeting Workplace Expectations: Percentage of Strongly Agree and Moderately Agree

	Overall Pre-Survey	Female Pre-Survey	Overall Post-Survey	Female Post-Survey	Overall Change Female Change
I understood what was expected of me	84%	79%	82%	93%	-2% +14%
I understood and followed the professional requirements	96%	92%	93%	100%	-3% +8%
I gained professional skills			100%	100%	

Both cohorts were in relatively consistent agreement as to their expectations and then their performance in professional skills, as indicated by the small quantitative shifts. In the interviews, the women had a keen awareness and a clear plan as to how they would show their professionalism. This did not mean they were beginning at an appropriate level, but rather they used the time on co-op to learn how to become more professional. Veera knew she started much differently than she left. "I think I was pretty rough around the edges when I entered there and it's really like, I mean...a year or two years

ago I don't think [laughing] I could have ever like, led my own meeting, or like gotten firm with, you know, contractors or inspection or whatever." The women did begin with perhaps less confidence in professionalism, but from their experience, they proved to themselves that they were capable of maintaining an adequate level of professionalism.

Considering the increase in confidence for the female cohort in all categories of *Academic* (technical skills) and *Work* (professional skills), the evidence thus far shows that a co-op experience provides opportunities to learn or enhance skills that ultimately lead them to believe they are more capable than first expected in meeting certain levels of performance, both technically and professionally.

Career Self-Efficacy: career development skills

A co-op experience can serve either as evidence that a student is on the right path, or a clear indication that they are not. The results of this section provided evidence as to the effectiveness of a co-op aiding in the development of career development skills. And again, these survey results are consistent with the interviews, where the women spoke of gaining insight into their major and confirming their fit, or finding strategies for finding their fit within a company.

In the table below, I have presented the *Career Self-Efficacy* survey results. Rather than including all of the data, I have included only those responses in which the students choose *Extremely Confident* or *Very Confident*. For those questions where the other Likert-scale options provided relevant data, I will include those results in the description.

Table 4.5 Career Self-Efficacy Survey Results: Percentage of *Extremely Confident* or *Very Confident* Responses

	Overall Pre	Female Pre	Overall Post	Female Post	Overall Diff Female Diff
Effective and Targeted Job Search	52%	42%	80%	80%	+28% +38%
Strong Professional Resume	71%	58%	80%	67%	+9% +9%
Identifying and Setting Career Goals	57%	51%	73%	60%	+16% +9%
Determining Best Fit for Company and Position	71%	67%	91%	86%	+20% +19%

In all of the career categories, the female cohort started with significantly less confidence than the overall cohort, and their confidence levels were lower here than any other section of the survey. However, the women did increase in every category and their increase was significantly higher in each category than the overall cohort. Most significant was the female cohort's +38% increase in their confidence in conducting an *Effective and Targeted Job Search*, and the overall cohort saw a +28% change. Both cohorts also had significant shifts in *Determining Best Fit for Company and Position*, which is very much related to their job search. These co-op experiences helped both to solidify perhaps what they will look for in a company and position, how they will do their search to meet those criteria, and their abilities in

determining their fit through the interview and other aspects of the hiring

process.

Table 4.6 The Co-op's Effect on Career Plans: Percentage of Strongly Agree and Moderately Agree

	Overall Pre-Survey	Female Pre-Survey	Overall Post-Survey	Female Post-Survey	Overall Change Female Change
I plan to complete my degree in the major that I am currently enrolled	98%	100%	95%	100%	-3% 0%
As a result, my academic degree plans may change	NA	NA	20%	20%	
I know what type of career I will pursue upon graduation	71%	76%	78%	80%	+7% +4%
As a result of my co-op experience, my career plans after graduation have changed	NA	NA	18%	20%	
As a result of my co-op, I gained career development skills	NA	NA	93%	100%	

In the post-survey, students were asked about the most beneficial and least beneficial outcomes of their experience, and the results were predictable.

Overwhelmingly, the top response was *working in a professional setting within my field of study*. And while a far second and third, the other two most common responses were *gaining or enhancing my technical skills* and *building my professional network*. When asked what was least beneficial, again a clear majority chose *building my social network*. With a far second being *gaining or enhancing my technical skills*.

SOURCES FOR LEARNING

In addition to gaining insight into which areas the students increased in confidence, the survey also identified the methods for learning. In the table below are the results from the questions that asked which learning methods they utilized while on co-op.

Table 4.7 Methods of Learning Survey Results: Percentage of Respondents Who Identified each Method

	Overall Technical Skills	Female Technical Skills	Overall Professional Skills	Female Professional Skills	Overall Career Skills	Female Career Skills
From my supervisor	18%	20%	17%	15%	20%	19%
From a mentor	15%	17%	16%	17%	16%	19%
From a co-worker	21%	22%	22%	23%	20%	24%

Formal company training	11%	8%	3%	2%	5%	5%
Self-taught on the job	19%	17	22%	21%	24%	24%
Opportunity for practice	15%	14%	20%	21%	12%	7%
Other	1%	2%	0%	0%	2%	2%

In this portion of the survey, there are slight variations in the results between the overall and female cohorts. The overall cohort cited *From a Co-Worker* as number one for technical skills, but *Self Taught on the Job* was the number one method for gaining professional and career development skills. The female cohort cited *Co-Workers* as the number one source of the technical, professional, and career development skills they gained. In the interviews, all 11 women talked at length about their source of learning and the importance of the people they worked with. Over and over they described their mentors, supervisors, and co-workers, even the men on the shop floor, as the most valuable resource to their learning. "I leaned on them [team members] a lot because there was a lot to learn and I had to learn it very quickly, so it's just really reaching out to them asking questions..." "Hey, I really need you to explain this, because it keeps coming up in meetings and I don't know what this is." Three women mentioned having access to reference material and reports, but the most significant source of learning for all of the women were the people. Over and over they described when they asked

questions, who they asked, how they asked, and the invaluable resource that was available through their supervisors, mentors and co-workers. This was the number one method for their learning.

While people were the main method for learning according to the female cohort and interviews, it is crucial to recognize that the people would not have been accessible without the women's willingness to ask questions. When the women spoke of learning from those around them, they also spoke of their own responsibility in learning from others. One theme was their willingness and rhetorical strategies for asking questions. "I would say that asking questions is the best way to learn and I know everybody says that but I don't think you actually know it until you start asking questions because you learn so much just from that." While it is the people who were the best resource for the women's learning, to access that information the women had to be willing to ask questions and ask for help. This can be difficult for a co-op student who realizes she does not know enough, yet does not want to ask too many questions and give the impression that she is incapable. These were the types of hurdles that the women overcame, as they negotiated the balance between knowing too little and knowing it all. As students, they may be the "expert" within a group of peers or feel the need to show they are knowledgeable, but they realized this was not the best method in the workplace. They realized how much experience their co-workers had, and it

was crucial to recognize and respect that. “Going there I realized you have to take the time to listen because you don’t know everything and other people know more than you.” They realized the importance of understanding their own limitations and asking questions, but not so many questions as to seem unable to work independently. Once the women began using the people as resources, they recognized how valuable they were to their learning. Another woman mentioned she would not have been able to meet expectations had she not used her team wisely. Thus, the most significant method for the women’s learning on co-op were the people they worked with, but in addition, there was the added component of the women being willing and able to ask questions.

THE REST OF THE STORY: OTHER THEMES FROM THE INTERVIEWS

The opportunity to interview 11 women for the qualitative portion of this study provided an endless amount of data to include. However, I am not able to discuss every point that was made, so I instead chose themes that were most prevalent. Those themes were leadership, gender, identity, and mentors. Had it not been for the interviews, these are the results and the stories that would have been missed, and more so, these qualitative results provide the study’s richest content.

A Positive Experience

After asking for their background information, the first question during the first round of interviews asked the women to “talk about their co-op experience this past semester.” The responses to this question were 100% positive. As mentioned previously, it was not possible to compartmentalize their experience by semester, so most described their overall co-op experience. Whether talking about the people and relationships they formed, the projects they were involved in, the helpfulness of their mentor and co-workers, or their overall experience, every participant spoke positively about their overall experience. Plus, every woman described accomplishments and real personal growth as a result of the experience. For one, she was most pleased because the experience solidified a career path: “It’s been a real eye-opener...I found something I really like to.” For another, she was pleased with the alignment between herself and her supervisor on the purpose of co-op: “It wasn’t for me to solely make money for school. It was for me to experience what being an engineer is like in the real world.” And that is exactly what she got. So though there were challenges, some larger than others, every woman had a positive experience as a female co-op engineer.

Effective Leadership Sources: Role Models and Practice

Leadership was the one NACE Career Competency that was not directly included on the surveys, but it was a consistent theme during the interviews. The discussion of leadership came in three forms - observing the leadership

of supervisors and mentors, practicing leadership in the workplace, and returning to campus with new leadership skills and goals. For the first, three women spoke of their mentors or supervisors as role models in representing strong leadership. One woman had the opportunity to work with the senior principal engineer in the group, who was the only other woman, and she had continually offered her expertise. “If I had questions about anything professional, she made decisions based on her education and job advancement.” As a leader, this mentor served as a role model and provided guidance to the student. Emilia’s mentor was transparent in his own work and family values, and she was able to observe ways in which he led with careful balance. He told her, “You’re in this job more than 50% of your week, so if you don’t like it, then what do you have in life?” Both of these were significant contributions to the women’s experiences because they both speak to two of the reasons why there are fewer women in engineering: lack of role models and difficulty in balancing life with a family and a career. (Dizikes, 2016). Whether they were aware or not, these mentors were providing valuable guidance that spoke directly to key needs of female engineers.

The mentors’ characteristics and styles provided examples of strong and effective leadership. One woman observed a good leader is one who steps back: “But he also understood enough that I knew something and I am

capable of figuring some things out.” Another recognized how valuable it is for a leader to offer feedback: “He helped identify at the beginning which areas I need to improve, and then push me to actually work on improving in those areas.” And another saw the willingness to share information, even beyond the technical: “He would explain things, like the political side of Company X, which was hard for me to grasp at first.” Having been able to observe these characteristics, and recognize their value, these women may be able to emulate them in future leadership positions, whether as a student or a professional.

In addition to observing leadership and recognizing effective practices, some of the women had an opportunity to serve in lead roles on their teams. (This number is difficult to quantify, because many women spoke of leading their projects, but it was unclear as to the formality of their leadership.) One woman’s main role was that of a project manager and she immediately recognized the challenge associated with her status: “That’s the unique thing is there’s a 19 year-old college student and saying, ‘Alright I’m here to lead the team,’ and to give them instructions. It can be, you know, a little difficult for people to, you know... I think I understand and what to work with.” All of the leadership practice the women gained was valuable in both providing an opportunity to enhance their skills, but it also allowed them to prove to themselves that they were capable of leadership positions. Most exciting was

when the women were inspired to take on more leadership roles, and then followed through once they returned to campus. When Emilia returned to campus, she was asked to lead her Enterprise team but was initially hesitant. Eventually, she did agree to the position as a result of what she had gained through her co-op. She explained the process she went through in thinking through her decision.

I was like, ahhhhh, okay. But because of my co-op and my internship, I was like okay, I know if nothing else I know who to contact. I know that I can ask people for help. And I feel like I've literally developed my leadership skills in the fact that I know I'm not alone. And if people ask me a question, I know I don't need an answer that second. I could always go back to you that day and then go out and find the answer for them and come back...Doesn't make leading things scary when you know you don't need to know everything, because I feel like coming into a lot of leadership positions you think, I need to know everything possible. But you really don't. You just need to be willing to contact people and willing to find out answers and willing to work with people if nothing else. I feel like that's a big misconception people get: they need to be perfect. They need to know everything. They always have to be there. Even if you can't be there you can delegate things. It doesn't all fall on your shoulders I think is the biggest thing I learned.

Leadership experience, regardless of the formality, is extremely important, which is why it is one of NACE's Career Competencies. These women were able to gain these skills and confidence, and then take them back to campus. One of the most significant leadership transformations is the story of Lida, which I have included in a later section.

Gender Does Still Matter

In this section, I have provided the results that are tied to gender and the significance it played in the women's experiences. As expected, when female engineers enter a male-dominated workplace, there are moments when gender is evident. But the issues surrounding gender were not always this obvious. The women believed gender was not an issue, yet some then went on to describe instances or workplace cultures where gender played a significant role.

In the first round of interviews, I asked the question: Did you notice any differences where gender played a role? In retrospect, I would change the question because some were unsure what I meant. The goal was to keep the question open, so as not to lead the women in any way, but rather to provide them an opportunity to talk about instances when gender may have been at play. All of the women did offer some type of response, even if it was that gender was not an issue. When women answered with this response, their discussions that followed typically did show something very different. They would go on to describe very clear issues where gender was at play. Based

on the results, gender quickly became a major theme in the data, but then why did it seem so insignificant to the women?

There are No Issues, but no women either

For some women, the response to the gender question was to share the imbalanced ratios or other observations related to numbers. The first similarity between all of the women were the number of other women, or lack of, in their divisions and departments. This was something 10 of the women mentioned, and while some downplayed the significance, they were well aware of their minority status and talked about the numbers.

- I guess I always realized I was the only girl out of all the engineers or our contractors.
- The only female electrical engineer.
- I was the only woman engineer there. Everybody else was older men.
- There were three in the entire department.

Most interesting was that while this was something they had noticed, many did not consider it an issue, more of a given. Veera, during her 16-month co-op in the pipeline industry did not realize the significant of her statement. "I've never really, I guess, run into any issues like being a female. I've never worked with another female engineer." She did not consider the lack of any other female on her team as being an issue with gender, nor did she recognize the system that was functioning in which there were no other women. Having come from a university setting where the ratios were also

unbalanced, this had become their life, their reality, and nothing they could change. “Of course engineering is male dominated,” stated one of the women. Another mentioned she “just stopped noticing after a while. It’s just kind of a thing.” Actually none of the women ever discussed the imbalanced ratios to be a problem, nor wished for anything more. To them gender was a non-issue. It was just life and something they learned to ignore. It wasn’t until they continued to talk about their co-op experiences as it related to gender that I found out the rest of the story. As they spoke of the non-issues, they were actually describing clear examples where gender was in fact at play, but they did not recognize it as that.

lida described the environment of her previous internship, just after high school: “I did get catcalled and inappropriate things were said to me, but you have to push through it, which is frustrating.” What struck me about this response was the clear frustration she felt, yet inability to take action and the assumption it was just part of the job. This paired with the timing, having come right from high school, could have been a very negative introduction into the engineering culture. Sara also recognized the challenges of a male-dominated work culture, as she would notice a shift or an end to the men’s conversation upon her arrival. In addition, she described herself as the type that would think about situations long after they had passed, obviously bothersome to her. “I have to be pretty strong compared to a woman in

some other field because of that mindset. Needing to get over it. Needing to move forward.” Over and over I listened to moments, responses, and challenges that the women faced which were clearly related to gender. Despite their stories, there was no indication of a problem, or even a complaint. If the women do not complain, why is it necessary to talk about these issues?

Stereotypes of Female Engineers

From their experiences, six women personally received messages of gender stereotypes, but none of the stereotypes were positive. As females, they were given the message that they were weak, soft, lacked intelligence, or lacked ability. When asked whether her questions would differ if she met with a male from a potential company compared to a female, Anna said, “Potentially. It depends on the male’s personality. I have met with some male engineers in the workplace that were against having more females come in the field of engineering, which is very sad in my mind.” That sadness rested on the stereotype that female intelligence and ability were in question.

To succeed, these women had to proactively counteract those assumptions. One said her male co-workers assumed she “wouldn’t get my hands dirty.” She had to prove that she was willing to do this. Another woman was made to believe that she, or other females, did not have the ability nor the intelligence required of an engineer. “Sometimes it seems like, maybe you

can't handle this project. There were specific engineers that would say that to me." With these stereotypes circulating, whether overtly or silently, these women felt they had to work harder to prove themselves and earn respect as a female engineer. All 11 women had the same challenge while on co-op: to earn respect as a young engineer, but more so, as a young female engineer. This challenge meant some felt they were being held to a different standard from others. Through hearsay, others heard stories of discrimination, such as salary. One student congratulated a female full-time employee on her raise, only to receive the response, "It's about time...I do just as much work as all the guys, but the guys get ten grand more." Another student listed the only other women she worked with, and none of them were engineers. "The only women contacted for work-related endeavors over the course of my co-op term were the secretary to plan a few of my meetings, a woman I had come in to teach a class from another company, and the women from HR who interviewed me about my mentor." The message she received - women are here, but not in technical positions. She believed, from speaking with other chemical engineers, "that women in this company hold less technical positions that don't necessarily have the same means of advancement...that is what some people say." Whether they experienced, heard, or observed, there were clearly stereotypes circulating that may cause question for the female engineers.

On a positive note, two women felt their gender served as a benefit to their experience because they saw themselves as having been treated differently because they were female. Their male co-workers were more helpful, kinder, softer, and shifted the discourse / language in their presence. Their own presence caused a shift. Iida described the result of having female leadership in the department, and while it was effective for her personally, she also recognized how it affected others. "My mentor, she was head boss and she was 30 something. So she was a young woman and people were used to respecting her, which made it easier on me and the other co-ops." With the mere presence of more females, the "man's world" culture was not as clear, nor was it the expectation that a "head boss" could only be an older male. Another woman felt "they treated you just like they treat anybody. Just because you're a girl didn't really matter to them. That's kind of more of the *Company X* culture of it." In these instances, gender wasn't a negative issue and sometimes served as a benefit. Overall, two women felt that gender really did not affect their work, nor the expectations placed on them.

Identity Shifts

On campus, the women have consistently been outnumbered by men in their classrooms, by both peers and professors. As established in the previous section, during a co-op, a female may be the only female engineer on the team or even in the department. With so few women visible in the field, there could be detrimental results. Iida described her own lack of self-confidence,

prior to gaining her co-op experience. “Before I thought that I could never do it. I wasn’t smart enough. And I wouldn’t fit in.” This was her starting identity as a female student majoring in engineering. Another key point she made was that her lack of confidence was not unique. “I think one of the hardest things being a woman engineer and going into the field is not having confidence.” These thoughts of inadequacy or doubt were not unique to her, as was shown in the consistently lower levels of confidence for the female cohort in the pre-survey. These were their stories, and the survey results provided the quantitative evidence. What causes the women to feel less confident as engineering students? While all new professionals may struggle with these feelings, what is the significance for female engineers?

I am an Engineer

As a result of the co-op experience, all 11 women described their experience with the same results - new found confidence. However, those results did not come easily, nor did they come quickly. Regardless, they all participated in a process that began with a lack of confidence and self-doubt, but ultimately concluded with not only confidence, but also a new identity. When the women began the co-op, as previously mentioned, many of them doubted themselves, even when they were clearly capable considering they were hired above many other, male and female, candidates. However, that was not enough evidence. Before the co-op, Emilia would have described herself as an electrical engineering major, but beyond a declared major, her identity was not that of an electrical engineer. Far from it, she felt she was unable to

even participate in the discourse or pretend to know she could talk about the work of an EE. Remember, lida even doubted herself to the point that she questioned herself, thinking perhaps she “could never do it.” As the women talked about their experiences and the results in the interviews, they were even a bit surprised at what they were capable of. “I learned that I’m capable of doing more things than I realized. Like I said, this is a huge learning experience for me just in general. But I learned that I can do a lot more. Whatever I set my mind to, I can accomplish.” Another said she was lacking confidence in her abilities and the knowledge necessary for an engineer, “but being able to work through a project of my own and put together a report and do it all start to finish confirms that I know what I need to do in this position and that I do put out good work.” As these women reflected on their experiences, they all described their own transformations with awe, pride, and a more tenacious eye towards their future as an engineer. They were able to do the work of an engineer and do it well. As she looked forward, one woman said, “I can and will be successful in my career no matter where it is at.” No one in the group could speak with such certainty prior to their co-op experience. Most significant in this identity shift is how they have moved from engineering major to Engineer. And even more so, Female Engineer. They are more confident in knowing that they can do the work of an engineer, thus, they are an engineer, or on their way to becoming one. They were all beginning to see engineering as their future professions, rather than as their

major. Their identities were moving towards *Engineer*. Emilia was as sure as saying, “I don’t feel like that person that says I *kind of* know what I’m talking about.” Now, she really knew what she was talking about. She felt like an *Electrical Engineer*.

Masculinity, in its Most Obvious Forms

In engineering, there were varying degrees of masculinity within the communities. For some women, the communities of some of the co-op placements were excessively masculine. Anna, Emilia, and Veera were those women who spoke of their historically masculine, mostly male industries and departments (test and development, oil, and pipeline). They best describe the cultures they were working within.

Anna: Test and development is literally one of those places where you can... if you can't take the heat, get out of the kitchen. These guys are going to dish out crap to you all day long and if you can't dish it right back to them, just like that, then like they will not respect you nearly as much. And so I've gotta say that I probably had a little bit more of a sailor's mouth now than I did before because it's a shop floor and these are some rough guys that I'm working with. But it was all fun and games ...so... I mean you kind... you start acting like a guy, like I've been like a tomboy all my life , but it's one of those things where I go in there, and you gotta get down, you gotta be ready to get dirty,

get your hands dirty with these parts and if they see a girl going in there doing that, they're going to respect you for it.

Veera: I mean I guess I always realized I was the only girl out of all of the engineers or are ... contractors but I don't..... I mean so at some times before they knew me it might play a role, but then once they got to know me then I was just one of the guys. Like then it was fine. I think this probably coupled with the fact that I was like, you know, at the intern level, and I was the only girl. And like, the pipeline industry - it's kind of old school in that ...respect. So I think I maybe had to prove myself a little bit more but ... once I got over that, I didn't really notice it at all.

Emilia: The only time that we ever really felt like we're a girl is when I would walk around the refinery out there in my ... and my steel-toes, a hard hat, flame resistant clothing and all that fun stuff. We were walking out there, and a lot of the contractors that work on the refinery helping install new things and stuff, they would just sometimes give you a looks like, oh you're a girl, kind of thing. Other than that, no one really treated me really differently. So I guess I was just lucky in that respect.

When these women described these places, they were not complaining nor did they talk about them negatively, to them it was a fact of life.

Just One of the Guys

One of the key moves in the women's identities who were placed in the heavily masculine departments and industries, like Anna, Emilia, and Veera, was to shift into a more masculine identity. These industries and departments were described as, "a man's job," "rough and rugged," and "good ol' boys club." To survive, these women saw the shift to be necessary in order to earn respect. However, none of them considered it to be a detriment, and they were all quite successful and thoroughly enjoyed their experiences. However, to earn the respect and to move from an outsider to insider, all three described a shift in their identities or a new identity as assigned by their community (such as *they* just considered her one of the guys.). It was common for them to describe themselves as one of the guys: "You start acting like a guy." Another said she was "just one of the guys." Neither actually described what that it meant to act or be one of the guys, but Anna went into greater description about exactly what she had to do and how she felt she needed to present herself. "You gotta get down, you gotta be ready to get dirty, get your hands dirty with these parts....a little bit more of a sailor's mouth....I got a little more rough around the edges from working there." While all successful, their success did partially come as a result of this gender identity shift, whether they felt more like one of the guys or the guys saw them as such. Regardless, for these women, they all spoke positively about the experience. When the women spoke of their identities, they were proud of their ability to become accepted and prove they could do the work.

They were not despondent of their new work identity, nor did they resent the men for requiring this. Anna, Emilia, and Veera spoke of their success in becoming accepted in their male-dominated, masculine workplaces, proud of both their technical accomplishments and their memberships. They didn't credit their identity as the key to their success, but rather their abilities to get the job done, to see a project from beginning to end, and ultimately the value their project brought to the company.

Finding Her Most Authentic Self

For two other women, their shifting identities were startlingly different. As a response to the gender related challenges, Sara and Jenni felt they were able to show more of their true identities, rather than presenting an inauthentic identity in the workplace. Sara was assigned company housing with three other men from another university in one of the company's apartments. She was not provided a choice nor alternative options in this living arrangement, so she was forced to live with them in an apartment for the entire duration. Throughout her time, she had numerous conversations with HR regarding issues and her preference for alternative housing, plus other issues, but to no avail. This was a very frustrating experience for Sara, but also an opportunity for reflection and to figure out how to best handle it. Jenni was assigned a supervisor, an older man, and he oversaw all of her time and projects. At some point during her co-op, she filed a formal complaint with HR regarding some type of harassment she had experienced

from him. (Being the details are not critical for this discussion, I am choosing not to include any specifics.) Both of these situations were quite different than all other experiences. Even in the previously described masculine cultures, there were no issues of harassment, nor did they work with men who were difficult and/or inappropriate. For Sara and Jenni, it was not the culture of their departments, but rather the misfortune of the situations. However, what was most significant were the similarities in both of their outcomes, the stark contrast to the shifting identities of Anna, Emilia, and Veera, and the conflicting results of the two sets of situations. While the other women succeeded with shifting to more masculine identities, these two women had a very different identity shift. Both experienced a transformation to become more self-aware and more comfortable as to what they considered to be their true selves. Sara, after careful reflection, came to realize she could be herself at work, and didn't need to put up a persona of professionalism, ultimately masking her true self.

I kind of reflected on the way that I behave at work and who I can be...I realized that I can still be both of those things [professional and mature] while still letting my fun-loving attitude come out. Really be authentic about who I am and outside of work, not really putting up a front at work, and just really opening up about who I am, and what I like to do, and where I come from, and where I've been, and where I'm going.

After her own situation, Jenni did not crumble, but instead found confidence in being herself. “I learned to be the most sincere real version of myself.”

Through adversity, both Sara and Jenni more clearly understood what they considered their true identities and felt more comfortable displaying them at work.

The Functions and Benefits of Great Mentors

When students work as co-ops at the company sites, there is typically a mentor assigned, but some mentor programs are much more formal than others. Small companies may merely assume that a supervisor will be both supervisor and mentor, but it is important to note that these may *not* be the same, as the roles they play can be different. However, when the women were asked in the interviews, some only had a supervisor, so they considered that person to be their mentor. Regardless, all 11 of the women spoke of someone they worked with, whom they considered to fill the role of a mentor, and described what that person did to positively contribute to their work. One woman questioned any method of learning other than her mentor. “Cause otherwise who’s going to teach you what you really need to do, honestly?” All of the women had a person or two whom they considered their mentor. And when they talked of their experiences, the role of a mentor was a theme that could not be ignored because of its effect on their learning and ultimate success. Iida’s story comes up again and again because of how often her experience was tied to the people around her. In addition to her

female mentor on the co-op, she had other effective mentors. “And he is who I looked up to for everything. I think it’s just really important, especially being this young and so inexperienced...I don’t know how well I would have done in my co-op if I didn’t have either of those two mentors.” Over and over, all 11 women spoke of the support and knowledge they received from their mentors that had a direct effect on their experience. After recognizing the critical role her mentors played in her experience, Lida had a newfound outlook on the importance of their role. “But you really do need a mentor at every stage. Even when you’re older, I think everybody needs a mentor.”

Based on the responses, there were two areas in which I will expand on their comments. First, the women spoke of the particular roles and actions of their mentor that were most effective. And second, they were able to articulate their results, in detail, that they believed were a direct result of their mentors’ support and guidance. Based on the survey, people were the number one method for learning amongst the women, and some mentors really functioned like a teacher. Each time Emilia talked about her mentor, her energy and positivity were heightened. “I had lesson times in my mentor’s office. I’d get in there and he’d be in on the whiteboard just going at it. I’m like, “Oh my gosh this is awesome!” Another woman used her mentor for the non-academic learning curve that is important in an organization. “He would explain things, like the political side of *Company X*, which was hard for me to

grasp at first.” But in addition to the learning, one of the most significant outcomes was the increased confidence in believing they were very capable engineers. “But he also understood enough that I knew something and I am capable of figuring some things out.” None of the women described a mentor who didn’t trust their capabilities. And one even stated: “He trusted me to do my job.” These were the ways in which these mentors provided the women what they needed to be successful as a co-op. The mentors had confidence in the women, which in turn helped to increase the women’s self-confidence. And while there was one woman with a negative experience, all of the others were appreciative of their mentor, recognizing that not all mentors are effective. “He was always building you up rather than a lot of places that tear you down a little bit.”

With the support just described, there were accomplishments and outcomes the women identified to be a result of their mentors’ support. “So I think he’s a lot of the reason that I was able to get so much done and learn as much as I did.” The support and effective mentoring made a significant difference in the work and results, which is a win-win for both parties. When determining the effectiveness of mentors, one woman identified a key characteristic of her mentor that made him so effective. This mentor had been a student co-op himself, so “He knew how interns were... And, like, he had the same questions that I had so he explained them to me in words that I could

understand easily. And he has helped me the most.” Finally, some of the mentor and co-op relationships did not end on the last day of co-op. Veera kept up her relationship and even used them once back on campus. “It’s nice that just because your job ended and then they did not stop being your mentors and they were so willing to keep going with you.” Two women spoke specifically of continuing their relationship with their mentors and talked about the types of conversations and emails they had been exchanging.

A Tale of Two Mentors

To illustrate the impact a mentor can have on the co-op experience, I will now focus on two students’ experiences with their mentors, lida and Jenni. The juxtaposition of these two women illustrates not only the importance of a mentor, but reaffirms that not all employees are effective mentors. Just assigning a mentor is not enough. These two stories are examples of the profound power of mentoring, but also the dangers associated with ineffective mentors.

lida’s mentor was her supervisor and also oversaw the department. After describing the seniority and supervisory role her mentor held, she went on to talk about what she particularly respected about her mentor. “And as a woman engineer, I really looked up to her and how she handled things, and how she displayed her leadership skills.” When lida described the personality traits of her mentor, these were significant due to the similarity between

herself and her mentor. One particular trait was a soft spoken demeanor. lida had always assumed her own soft spoken demeanor was uncondusive to a leadership position. Her mentor was able to provide an example of someone who can be a leader and step up when needed, while still being herself. This was truly inspiring to her. Enough so that she is returning to school with plans for pursuing leadership positions with the evidence that she may be capable based on what she saw in her mentor.

Jenni had an older male mentor, nearly 40 years her senior. “My mentor was a 63 year-old man who had a lot of control over my co-op term.” Instead of finding inspiration from this mentor, the student was forced to file a formal HR complaint for harassment. After her report, she did seek another female employee as a new mentor, mostly because she had heard this woman had a similar experience. These two women’s stories were the most extreme on both ends of the spectrum, but important to recognize the significant outcomes that are possible due to the effectiveness, or lack of, of a mentor.

While lida’s story provides an example of the significant positive effect of a female mentor, I am also careful not to make the assumption that only female mentors are most effective for female engineers. There were other women with male mentors who were also very effective. Emilia spoke fondly of her mentor and all that he did on her behalf. “He would help me no matter what.

He never was prejudice against me because I was a girl. If anything I felt like he helped me more.... At least my mentor was very much - I want to teach you all you need to be a good engineer. Whether you are male or female, I don't care what you are." She was very much positively influenced by her mentor, and it was clear that he took his role very seriously, but it is also important to be aware of issues such as the one described. Jenni provided some closure in her reflection on the experience. "It was really unfortunate but I feel like I gained some insight into workplace conduct and will be more aware of that type of thing in the future not only for myself but for other female engineers." Though Jenni's situation was unfortunate, there is the possibility that her awareness and empathy may make her more effective in mentoring other female engineers. The key takeaway to this tale is the reminder that all mentors are not created equal, and their influence is significant enough to potentially make or break the co-op experience. These are the types of situations that can heavily influence the retention of female engineers. And as the first student shows, a mentor also has outstanding power in creating future female leaders that will inspire upcoming engineers.

CONCLUSION

As had been the goal at the start of this research, I was most interested in providing a co-op study that had some consistency with other work that had been done in the co-op field, hence Raelin's self-efficacy research, but I was

also not satisfied with the limited data of a quantitative study. I wanted to learn more. After reviewing the results from both the surveys and interviews, this data has provided the evidence to what I believed has been missing. When we only rely on quantitative measures, the results of co-op experience may not look all that different for men versus women; but if we take the time to ask the women and allow them to tell their stories, the results may look different, as they have here. In this chapter, I have provided a much more detailed account of the students' self-efficacy in their academic, work, and career, skills, because I not only relied on the numbers, but I also have the rest of the story, from the women, to better understand how and why those numbers came to be. And in the last section of this chapter, I have captured four key themes that may have been impossible to otherwise access. This data shows us that cooperative education is much more complicated than sending a student into the workplace, and it is actually an intricate method for learning that results in holistic outcomes. With this data in hand, there are now new opportunities to understand the experience of a female co-op engineer, but even further, to better understand what to do about it.

Taking these results, we will now move into the final chapter in which I have saved for the theoretical analysis, as well as an opportunity to offer a theoretical model specific to female engineers in a cooperative education program. The results of this chapter have provided the themes and questions

which I will use as a focal point for the theoretical analysis: learning, gender, identity, and communities. These particular themes address my earliest research questions, though the answers have come from a careful balance of focus and freedom in exploring those questions, as was necessary with my feminist framework and methodological approach.

An Efficacious Space in a Community of Practice: Aligning as a Cyborg Engineer

In a published chapter within the *Handbook for Research in Cooperative Education and Internships*, Howard (2012) urges those in the field to make research a top priority.

In order for research to have a more prominent place in the field of cooperative education, co-op educators need a diverse range of more sophisticated models that attempt to describe and understand the complex cognitive, social, and career-building outcomes of alternating work and study and how these outcomes happen (p. 6).

Howard is making the call for research that enlightens the co-op process and outcomes, opening up the black box cited 24 years ago by Ricks, Cutt, Branton, Loken, and Van Gyn (1993). In their opinions, co-op literature at that time “reveals limited theorizing of cooperative education” (p. 7). They go on to acknowledge something happens in a co-op, but mysteriously. “In the empirical studies of cooperative education, investigators have determined that “something happens” when students are enrolled in cooperative education. In these studies cooperative education is often undefined or inadequately defined and how it works is not explained” (Ricks et al, p. 11). Grosjean (2004) examined the differences in learning based on context, classroom versus co-op, but could not close the gap: “We do not fully understand how skills and competencies are acquired” (p. 34). Johnston, Angerilli, and Gajdamaschko (2012) echoed the same.

As a result of this study, I have answered Howard's call by providing a model to describe the "complex cognitive, social, and career-building outcomes," while also contributing to understanding cooperative education's black box by unpacking learning and outcomes. Most important to the population for which I am responding, female engineers, I offer a stance within the binaries of gender, identity, and learning that are at play within a community of practice and provide an alternative to choosing sides.

The stance which I propose is based on Haraway's (1991) *cyborg*, proposing a more specific version, *The Cyborg Engineer*. By moving past the either-or restrictions of these binaries, the solution opens up opportunities that are no longer constrained by labels, norms and standards with the goal of providing more opportunities for women. More women, however, is not as simple as getting more women in the door, but rather understanding why there is a need for more women, the value of their fresh insights and perspectives to provide something new, and then allowing the insights to transform, meaning those insights can then be shared by more than just the women. Ultimately, it is the entire community of practice who benefits from more inclusivity, providing a more diverse community of individuals the opportunity to participate as members. With more women and new perspectives, barriers

may seem penetrable, and with the inclusion of more diverse perspectives, the community of practice is transformed.

Table 5.1 The Binaries within a Community of Practice for a Female Engineer

Gender	Male / Masculine	Female / Feminine
Identity	Student	Professional
Learning	Skills	Knowledge

Within a community of practice, I have identified three binaries at play which affected the women's experiences and outcomes. First is gender, as there is a lot of attention given to gender in engineering considering the recent attention and initiatives focused on filling employment needs in engineering, specifically targeting women, as one of the groups, to fill those gaps (National Science Board, 2016). In addition, there are also stereotypes and assumptions based on gender that are still at play. And while gender may not seem like a choice, as I had illustrated in the previous chapter, there were clear instances when the women chose more masculine or feminine identities. Identity is the next binary, as women were in constant flux between student and professional. As co-op students, they were students, yet the expectation in the workplace were similar to those of a professional engineer. And lastly, the learning that the women experienced involved both skills and knowledge, with the two being different and producing equally different outcomes. To articulate these three sources of negotiation for female

engineering co-op students, I will unpack the terms and factors at play within each before then moving into an alternative space from which to work which rejects the necessity of choosing sides.

Through this study, I had an opportunity to ensure the female perspectives were not silenced. “If values and interests that can produce the most critical perspectives on science are silenced through discriminatory social practices, the standard, narrowly conceived conception of scientific method will have not an iota of a chance of maximizing either value-neutrality or objectivity” (Harding, 1991, p. 41). The results of their voices have provided a model, which I will later discuss in detail, that gives women a space from which to work within their communities of practice, ultimately providing an opening into the engineering field for others to follow and a chance to transform communities for more inclusivity, rather than relying on labels that can promote exclusion and restrict access for *Others*. The model and conclusions which I offer were a result of the women involved in this study, because they were able to provide the crucial insights and stories to allow me to better understand their experiences as female co-op engineers. Thus, this model rests heavily on the inclusion of diverse perspectives, specifically focusing on women in this study, because without them the model would ultimately fail.

Having considered Harding's (1991) *Standpoint Theory*, she had made the point regarding *standpoint* versus *perspective* which I had pointed out in the previous chapter. While the women did offer their perspectives, there were also clear moments in which I was clearly hearing about their standpoint, because they described their struggles, and even the realities where underlying systems maintained unjust social orders. Two examples in particular are rather striking in terms of the women's stories uncovering what was lying beneath those struggles, and why the systems allowed it to happen.

Anna was a clear trailblazer and provided numerous examples of instances where she tested boundaries and refused to accept the norms. Before leaving her summer internship, Anna had an appointment with an HR rep for an exit interview. During that interview, Anna made it clear she wanted to return to the company, but also had specific plans as to where she was most interested in working. She made the request to Human Resource to be placed in the Test and Development Department for an upcoming co-op. The HR woman's response was, "we've never had a girl ask that before, so I'm going to say yes." Based on the response, it would seem that HR, even being a woman in that position, had not considered it an appropriate placement for women. But when someone brought this norm to her attention, she was willing to consider the request. This provides a glimpse into a functioning,

underlying system, whether the community is aware of it or not. Here there are certain types of people, or co-op students, who are best suited to Test and Development, and Anna was not one of them, nor were any other female co-ops. However, Anna was not dismayed by the response of this woman, and both her interest in the department and the confidence to ask for the placement caused her HR representative to see differently. Anna described even the woman's physical reaction accompanying her response, "And she looked at me funny." Ultimately, Anna got what she asked for, but only because she advocated for herself and took an opportunity to break stereotypes and the norms of that system.

Jenni's story is another example of Harding's *Standpoint Theory*, as she clearly struggled through the difficult situation with her mentor. "Realizing that I could not just power through the problems I was having with my mentor over the course of the co-op was very challenging to me. It took me some time to really recognize the inappropriate behavior and to do something about it. Speaking to my manager and HR was really challenging for me socially." In her situation, her mentor was also overseeing her work and had control over her co-op experience. As is clear from her description, the entire experience was difficult, yet even more so when she learned that this had not been the first time an incident such as this had occurred. I wonder how Jenni felt when she realized this had happened in the past, yet it was still

happening now within the community. Jenni's awareness of the underlying systems may have become clearer once she discovered this pattern. Power and authority was given to older, white males. Even the support she received, which was seeking her own mentor with a similar experience, provides evidence of how the system was set up to respond to these complaints, or not. (Jenni did not talk about HR's response nor how they rectified the situation.) Both of these women had different choices in how to respond, yet encouragingly, they both chose disruption. Anna had initiated her request and was not discouraged by the response; she pressed onward. Jenni did not suffer in silence, but instead utilized the resources available, whereas she could have stayed quiet and let it continue. Though she may not have seen any immediate results during her co-op, Jenni's action may have made a difference in the system for future women or co-ops. Both women played a role in attempting to disrupt the system, which are both excellent examples of *Standpoint Theory*. When Anna and Jenni entered their communities, they were outsiders, but it was their perspectives and responses as strangers that allowed them to identify the systems which were invisible to those deeply entrenched.

DEFINING LEARNING IN COOPERATIVE EDUCATION

The first step in this model is to unpack and define *learning* in cooperative education. The relationship between cooperative education and learning may seem too obvious to require any comment. Though one would think learning

is *the reason* for cooperative education, there is actually some discrepancy. Rowe (2015) argues against co-op as a learning experience, and makes the call to move away from it to better accommodate the students' notions of co-op as a work experience.

My point here is that it may be a mistake thinking and referring to the work term as a learning experience. Most students see the work term as a job, with all that that means in terms of tasks, performance, etc. Certainly most of the co-op students I have known and studied have the same feelings and attitudes towards their work term jobs (such as commitment, pride in their performance, motivation, satisfaction) as adult workers have, and regard those jobs as primarily work even if temporary or short term, not education, and even though they may have learned a great deal on the job (p. 105).

Here we arrive at yet another binary - co-op as work versus co-op as learning. While her argument partially rests on how the students internalize their co-op, I do not believe this is enough of a reason to abandon our research on co-op as a learning experience. I would argue that it is a mistake to believe it cannot be considered both work and an educational learning experience. I very much disagree with her argument, and using the results of both the quantitative and qualitative portions of my study in correlation with the theoretical framework of Wenger's community of practice, there is

evidence that co-op is both work and learning and compliment one other.

Work is learning, so we cannot separate learning from work.

If we consider co-op to be an educational learning experience, I must first identify what is learned. To do this I clarify a significant aspect of this argument - the difference between learning skills and gaining knowledge. At first, these two terms may seem to signify the same co-op outcome, but I would argue that they are very different. Understanding these differences then leads to identifying how gaining knowledge is a key aspect of the co-op experience because of the role that knowledge plays in one's identity. It is easy to interchange the terms skills and knowledge when describing learning, but the two terms are not mutually exclusive. Most co-op research on learning focuses heavily on skills. When a study looks at the full time job placement of co-op students, ultimately they are measuring career development skills. Grade point averages are tied to academic skills. A review of student evaluations by a work supervisor would point to the students' professional skills. Co-op research has focused heavily on learning skills, but at what expense? Missing then is the learning in co-op that produces changes in identity, and skills alone are not solely responsible for these changes. I propose a focus on knowledge to understand what else is learned through cooperative education and why it is important.

Before unpacking the significance of knowledge, it is necessary to define skills and explain their characteristics. Skills are tangible tasks, useless without action. One must *do* the skill for the skill to be of any use, otherwise a skill sits dormant. The key characteristics of skills in a cooperative education context are as follows: measureable, practical, predictable, timely, and requiring action. Skills are measureable because there are ways to check and measure skills. Through the quantitative portion of my study, the data represented the students' confidence in academic, work, and career development skills they learned (or enhanced) while on co-op. This was an extensive list of skills, specifically in the work and career development sectors. Skills are practical, in the sense that they pertain to some portion of the co-op experience, whether the technical field or for professional use. In a co-op, the skills are also relatively predictable. When a mechanical engineer goes into a co-op experience, she can predict to some degree the types of skills she will gain or refine during her experience. And lastly, skills are timely, because they are relevant in the present, and while they may be useful later on, there may be some question as to their future application. The skills gained during co-op are easily identifiable and the lists are endless when we consider the gamut of skills in a workplace setting. Research has adequately proven that students learn new skills as a result of their co-op experience.

Knowledge is different from skills in almost every attribute. As Table 5.2 illustrates, for every characteristic of a skill, there is an equal and opposite characteristic of knowledge. By defining these two terms and showing a visual of the differences between them, I do not wish to create a dualism, because there will be overlap between the two, and the distinctions are not as neat and tidy as the table suggests. What I do hope to bring with this idea is to recognize the differences in what students *learn* during a co-op experience - skills and knowledge - arguing that knowledge is most significant for this discussion because of its relationship to gender and identity within a community of practice.

Table 5.2 Characteristics of Skills versus Knowledge

Skills	Knowledge
Measureable	Limitless possibilities and unnecessary, sometimes impossible, to measure
Practical	Relevancy to be determined
Predictable	Less predictable; future use is impossible to predict
Timely, in the present	Relevant in the past, present, future
Requires Action	Does not require present action, but may influence future action

The knowledge I am referring to is a something to be gathered, held, and retained, unable to be quantified or measured. Knowledge is not only living in

the present, but simultaneously living in the past and future. Knowledge is always alive and working, making its relevancy impossible to predict. And while knowledge may be practical in the present, it does not have to be. There is still value in accumulating knowledge, regardless of its present use. In a co-op, the skills are predictable, whereas the knowledge can be very much unpredictable, as there are no limits as to the knowledge that can be gained. The vastness of knowledge allows limitless possibilities. Unlike skills, knowledge does not require action, so while it may mean there is knowledge of *how to*, knowledge does not require the action of *doing*. Knowledge is still living knowledge even when dormant, because it is working in the background. Defining these characteristics of knowledge is crucial for the next level - the relationship between knowledge and identity. Identifying skills as an outcome of co-op is nothing new and research has done an adequate job here. What is new is the differentiation between *learning skills* and *gaining knowledge* and the significant relationship between knowledge and identity in a co-op context. Knowledge, as it relates to identity, is a learning outcome that has been nearly silent in co-op research and yet so necessary to understand the experience of female engineers.

Introducing Wenger's Community of Practice

Cooperative education is an educational experience where a plethora of learning occurs, but this study ensures there is adequate attention on learning *knowledge*. Knowledge is a key component to the model because

the entire process of a co-op occurs within a community of practice, and there is no community without its members having the *knowledge* of what makes up their community. Before I go too deeply into this relationship, I will first provide a short description of Wenger's *Community of Practice*.

Wenger's (1998) work proposes a social model for learning that is far different than the learning models we are accustomed to in an educational, classroom setting. Thus, his work has provided a very different perspective on how people learn and their motivation for learning. Wenger argues that the most significant learning occurs in communities of practice, and these communities are everywhere, not just in an educational setting. (Actually, our educational systems are sometimes least conducive to this providing type of community.) We are all members of multiple communities, through family, work, school, church, or hobbies. Communities are essential to our daily lives, yet they can go unnoticed because they are so ingrained in who we are. "Communities of practice are an integral part of our daily lives. They are so informal and so pervasive that they rarely come into explicit focus, but for the same reasons they are also quite familiar" (Wenger, 1998, p. 7). While the communities we are a part of are implicitly familiar, then new communities are explicitly unfamiliar and strange. The co-op worksites where students inhabit are communities of practice. Thus, each student who leaves campus to work as a co-op student in a company or organization works in a

community of practice. If a student is new to the company, then the co-op company or department is a new community of practice, and the students will arrive at their sites as newcomers, beginning with very little, if any, knowledge about the community.

Within these communities of practice then, the co-op students are participants. Wenger defines participation: "Participation here refers not just to local events of engagement in certain activities with certain people, but to a more encompassing process of being active participants in the *practices* of social communities and constructing *identities* in relation to these communities" (Wenger, 1998, p. 4). Participation is not just joining a group, but engaging in the group's practices and determining where one belongs within the group. Thus, the depth and difficulty of learning is magnified as students are simultaneously learning both skills and knowledge, while mediating the challenges associated with negotiating these communities. Wenger's social theory provides an important aspect of learning that is crucial to my argument - the most significant learning on co-op is being a part of a community, negotiating the community, and ultimately deciding how that community will influence one's identity - "the learning that is most personally transformative turns out to be the learning that involves membership in these communities of practice" (Wenger, 1998, p. 6). This personally transformative learning is what I found to be most significant in the

research results. The students were not just leaving their co-op sites having gained a new list of skills for their resumes, but rather they were leaving with new identities. Within these communities then, I have identified three areas of negotiation for the women that were most significant to the outcomes of cooperative education. These were gender, identity, and learning within a community of practice.

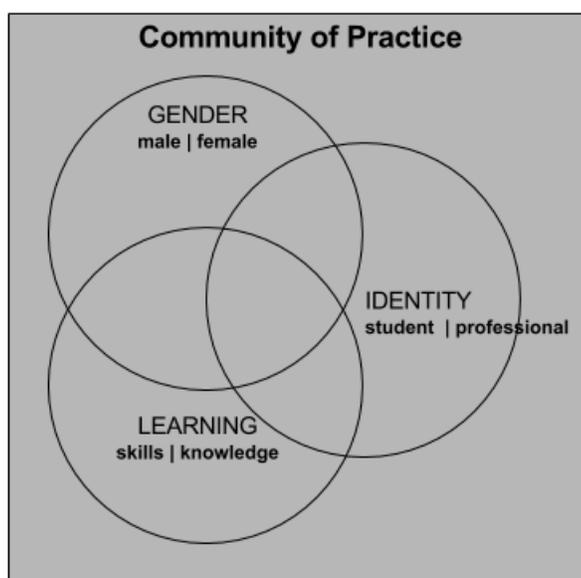


Figure 5.1 The Relationship between the Binaries of Gender, Identity, and Learning within a Community of Practice

When beginning their co-ops, the women entered with ties to each of the circles - they arrived as female students who had prior skills and knowledge in their designated major. They were recognized by their communities of practice as both women and students, with possible discrepancies in their own self-assessment of skills and knowledge compared to the company's

assessment. (Meaning, for some women, their companies were more confident in their skills and knowledge than the women, due to their uncertainty in how well their classroom learning would transfer to a co-op setting.) The companies felt they had adequate skills and knowledge because they hired them, but the women were not always sure. As indicated in Figure 5.1, there is a direct connection between their gender, identity, and learning within a community of practice, and this relationship is supported by Lave and Wenger (1991) who argued, we cannot separate the two: “...learning and a sense of identity are inseparable. They are aspects of the same phenomena” (p. 115). As I will go on to show, these areas of negotiation are not static either, but continually changing, ultimately transforming the individual and even the community of practice. By examining these connections and outcomes, I offer an opportunity to better understand the learning outcomes of cooperative education, how these outcomes affect the students, and what we can do as co-op practitioners to compliment the students’ experiences in their communities of practice.

OPERATING WITHIN THE BINARIES OF GENDER, IDENTITY, AND LEARNING

Using the community of practice framework, the knowledge gained during a co-op are all of the *practices* that make the community. When Wenger uses the claims processing model, he identifies their practice as “what these claims processors have developed in order to be able to do their job and

have a satisfying experience at work” (p. 47). These are routines, rituals, symbols, conventions, stories, histories, and more. They are both explicit and tacit, what is said and unsaid, and practices both represented and assumed. (Wenger, 1991, p. 47) Knowledge then is the awareness of these practices that make up the community: “the social and negotiated character of both the explicit and the tacit in our lives” (p. 47). This is the knowledge the women described gaining through their cooperative education experiences, such as the woman who asked her mentor to help her understand the politics of her community, or the woman who recognized the conversations ending when she arrived. Traditional co-op research on learning does not tend to focus on the community’s practices as part of the learning experience, but it is the community that transform the participant’s identity. “We all have our own theories and ways of understanding the world, and our communities of practice are places where we develop, negotiate, and share them” (Wenger, p. 49). Thus, cooperative education offers an opportunity in a new community of practice for the students to develop, negotiate and share their ways of understanding the world, which results in far more than a line on their resume, rather they are transformed in big and small ways.

Complicating Gender for Female Engineering Co-op Students

For the women in this study, their gender was an important aspect of their experiences because they were females entering a male-dominated community. These women were entering sites where they were one of few, if

not the only woman, because the reality is that there are far fewer women in the field. (Crawford, 2012; National Girls Collaborative Project, 2016; National Science Board, 2016) Considering this, their gender was a significant piece of their identities as female engineering co-op students because it put them into a minority status. But it is not only their status that complicates these communities, insomuch as it is their acceptance of the limited presence of women and the reluctance to question why these communities had so few women. The problem being - these communities will continue to operate *as is* unless someone arrives who notices this discrepancy and questions as to why it has to be this way. Anna did not care that there were no women in test and development - she asked to work there anyway.

When I asked the women in the interviews, specifically about gender or related issues, the common response was to deny any issue nor any significance related to their own identities as women in a male-dominated community. However, they did consistently cite the lack of female co-workers, mentors, or supervisors, and the lack of women was not surprising nor abnormal to them, rather it met their expectations. Their response insinuated that the gender ratios were obvious, glaringly obvious for some. When the women dismissed the significance of these gender ratios, they were participating in normalizing the lack of females and neglected to

recognize any significance nor detriment to themselves or others. They were missing key aspects of not only their own situation, but the bigger picture and corresponding societal implications. In the women's defense, they had come from an academic setting where most of their peers were male, and even their professors were more typically men. As female engineering students, they had already become accustomed to the male-dominated culture and even went so far as to accept the lack of women. The women normalized the absence of other women, so though noticed, it was not considered to be a problem. Harding (1991) disagrees with accepting the absence of women and argues against normalizing the lack of females in science. Her argument goes further than increasing the number of women, specifically including more women to provide missing perspectives. As I will carefully argue for too, it is not a matter of more women, but more women who arrive with clarity and purpose for changing the norm. If we were to add the perspectives of those who have been historically absent or lacking the agency to contribute to their communities, the status quo may then be disrupted. When western, white, male co-op students for whom the system was designed enter U.S. companies and their engineering departments, they most likely feel they belong, but comfort means the system is too familiar and beneficial - there is no impetus for questioning. They are unable to see the system with any other perspective, so they do not recognize problems nor absences. When male co-op engineers arrived on site, did they wonder where the women were?

Most likely not because they were accustomed to being part of a majority, both in their classes and in the workplace, where there were few women, thus giving no reason to ask why there were not more women. Most likely, they would not think to ask the question.

When the call is made for more women then, it cannot be as simple as numbers. The call must be two-fold, both a call for newcomers, but also a call for action. It is the newcomers who bring a new perspective; they see things differently, but should then question the normalized behaviors and practices. “Women are valuable ‘strangers’ to the social order...the stranger can see patterns of belief or behavior that are hard for those immersed in the culture to detect” (Harding, 1991, p. 124). Only when there are proactive outsiders who will question that which has been considered normal will those normalized practices be scrutinized. It is the stranger who can see what is strange, not the majority for which decisions were made. The goal is to make strange what is familiar, so that when women enter a co-op and do not find other women, they notice this to be a problem, think critically about the lack of women, and ask why. Action does not have to be on a grand scale, even an awareness of the skewed ratios and a willingness to ask questions to uncover why their community is made up of men constitutes action. Whether a candid conversation with a trusted mentor, an informational interview with HR, or even a casual conversation with co-workers, this can serve as

information gathering towards understanding and uncovering the practices which are excluding certain people. The questions can be as simple as the following:

- Do you have any diversity initiatives to recruit more women?
- Do you have any programs available to support women in the workplace?
- How successful have you been in retaining women at this company?
Why have some left?

Action does not have to be formal and it does not have to be big. Rather, the action of consciously questioning, identifying reasons, and considering potential solutions is a simple way to begin.

Without other women, not only is there a limit in perspective but there is also a lack of camaraderie for the women who are present. Women historically have struggled when they are limited in bodies, as de Beauvoir recognized early on. "The reason for this is that women lack concrete means for organizing themselves into a unit which can stand face to face with the correlative unit." (de Beauvoir, 1994, p. 9). Strength can come with numbers. When there is only one woman, she may struggle without the camaraderie, support, and additional ideas of other women. When there are more women, this brings additional ideas, a stronger potential for action, and a cause for others to take notice. With more women there is more opportunity to infiltrate

on a larger scale, thus a potential for more widespread change. So while I do not want to only advocate numbers for numbers, there is value in increasing the number of women, especially when they are the women who will refuse to accept their situations as that which has always been and instead ask questions and consider how they might respond.

Denial, normalizing, and low numbers provide no opportunities to make a difference, and neither do silent women who cannot recognize the systems at work against them. “Successful (and unsuccessful) women who say “I’ve never experienced sexism” invariably have done nothing to challenge what was expected of them as women” (Harding, 1991, p. 67). As I will continue to argue, we need to ensure that these female engineers understand their plight not as normal, but as odd and worthy of questioning. And though it may seem to offer no choice, there is always choice and there is always some action available. ...”many women in science who make the equity claims do not offer a challenge to the existing social structure or politics of the natural and social sciences. This is a problem” (Harding, 1991, p. 33). There is then the need for women, but women who are willing to scrutinize and speak up. And women who recognize there are always choices they can make. Ultimately, our co-op women need more women, but they need to also understand how they can become *those* women within their communities who uncover underlying issues that others are unable to

recognize, ultimately resulting in crushing barriers that had been preventing access to that community.

Finding Choices Amongst the Chaos

In Haraway's essay, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective," she compliments Harding's call for a feminist science which expands the perspective to be more inclusive of both women and minorities, rather than the historically (white) male-dominated models. Her call is for an inclusive science with perspectives that offer an alternative to the limited dominant viewpoint, ensuring groups speak up but no group is spoken for. As I have shown previously, female co-op research has not always provided the female co-op's perspective, but instead it has been the supervisors and program coordinators/directors who have spoken about the student experience. No one should speak *for* the women, rather the women need to speak for themselves so we can understand their experiences and their perspectives. Including their voices does not only benefit the women, what we will learn also benefits the employers, the universities, and most importantly, future women. For Haraway (1991), her argument is for the sciences to be more inclusive, recognizing the widespread benefit. A more inclusive field means that everyone benefits from the diversity and reflection on how domination and oppression play out, thus using that awareness for change. "Feminists have stakes in a successor science project that offers a more adequate,

richer, better account of a world, in order to live in it well and in critical, reflexive relation to our own as well as others' practices of domination and the unequal parts of privilege and oppression that make up all positions" (p.187). She believes feminists must insist on accounts that are more inclusive, thus more telling from perspectives that were previously left untapped, or even worse, attempted to be accessed by others who were not in those positions. "The standpoints of the subjugated are not 'innocent' positions. On the contrary, they are preferred because in principle they are least likely to allow denial of the critical and interpretative core of all knowledge. They are savvy to modes of denial through repression, forgetting, and disappearing" (Haraway, p. 191). Haraway is specific in bringing in those from "subjugated positions". The female engineering co-ops in this study are but one. Those who have occupied subjugated positions are valuable because the goal is that they not sit back and allow their communities to carry on, rather they are in tune with the practices that repress, forget, and allow some to disappear. Once women recognize who their community is made up of and why some are included while others are excluded, it is important to recognize the choices and opportunities that are available in responding and influencing the community. Anna provided an example of an opportunity she had to not accept that which was *normal* in the community, and she took action to make an attempt to change the community of which she wanted to be a part. One morning on an early shift she began a

conversation with one of her male co-workers. He immediately responded. "Hold on a second. I'm not used to a female voice this early in the morning." She could have stopped there, accepted the practice as one of the norms, and stayed quiet, ultimately accepting that women were not a part of the community. But instead, Anna didn't accept this as a norm and instead provided an action and a response that made it clear this was not acceptable. "Oh, okay. Well I guess you'll have to start getting used to it, because I kind of want to work here." This is but a small example of the insights that we are calling for when we call for more women who are privy to the systems at play and will no longer silently allow these to be considered acceptable. Anna saw this scenario provided choices in how to respond. Harding and Haraway are making their arguments for a more inclusive science, whereas this is equally applicable to these communities of practice where female engineering co-op students are entering. Both theorists then compliment the argument for not only more women, but a certain type of woman who is aware and willing to take a critical look, uncovering systems and functions that have been exclusionary and finding choices within those systems.

Aligning in a Community of Practice

Ultimately, a community is created and maintained by its members, so with more women in the engineering communities who are present and participating, there is a greater likelihood that the community will change,

compared to a few silent or no women at all. The way in which a community is maintained is important to unpack, because it is not always those who claim to be in control that ultimately maintain the practices of a community. While much more complicated, I will summarize how members belong in a community to understand how the community is influenced by its members. Wenger (1998) identifies three distinct modes of belonging: engagement, imagination, and alignment. "Engagement in practice gives us certain experiences of participation" (p. 150). In addition, it is composed of shared histories, relationships, interactions and practices. (p. 174) Imagination is then to take the experiences and knowledge of the community and create new images of the world and ourselves based on that knowledge. "My use of the concept of imagination refers to a process of expanding our self by transcending our time and space and creating new images of the world and ourselves" (p. 176). And finally, alignment is when one belongs to that community. "Through alignment, we come part of something big because we do what it takes to play our part" (p. 179). But the act of alignment is more complex than just becoming a member, because it can "amplify our power and our sense of the possible. Alignment, however, can also be blind and disempowering. It can be unquestioning allegiance that makes us vulnerable to all kinds of delusion and abuse" (p. 180-81). When I speak of choices and action, it is in the alignment step that women have the opportunity to passively follow, actively reject, or a more moderate response. Anna and

Jenni provide insightful examples of their decisions *not* to align, but rather disrupt those systems at play. The key is the consciousness to identify whether it is a strategic response or a static, silent acceptance, sometimes even unconsciously, the type of response Wenger found created the vulnerability he spoke of.

For the co-op women, they were faced with practices in their communities that they may have not agreed with, but it was ultimately their choice in how to respond. Some faced stereotypes against women - women could not do this work. There were also expectations believed to be unattainable by females - this work requires her to get her hands dirty, and as a woman, she won't do that. There was even a clear way of talking and joking - they were rough and rugged and spoke with a sailor's mouth. In terms of their identities within their communities, I did not see evidence the women recognized their choices, because none of them spoke of an alternative. Anna, Emilia, and Veera seemed to think their only option, in order to be accepted, was to be seen as one of the guys. Anna had worked to get into the community, but her participation was as one of the guys. All of them, rather than choosing to participate as a woman within their male community, seemed to choose to be seen as more masculine. No one described options nor a preference to reject the necessity to be seen as one of the guys. This is where it becomes critical to analyze the role of identities within the communities of practice. The

women's identities were crucial in this process because it was through their use of fluid identities where choice and agency were available in how they responded and who they chose to be in their co-op communities.

Exercising Fluid Identities

As was the case for those women who felt others considered them to be one of the guys, they seemed to have shifted their identities in order to find their place within the community of practice. I am using the term *fluid identities* to represent these shifting identities, because identities are continually in flux as a result of our experiences. The accumulation of experiences provides different pieces to our identities that are available for use. As I have been arguing for in the community of practice model, the women's identities were affected by the communities of practice and their negotiation of gender, identity, and learning within the community. When I listened to the women talk about their co-op experiences, they were continually challenged by the binaries within these sites of negotiation and responded in very specific ways. What I did not hear when they spoke of their response was their awareness of the bigger picture nor the option of choosing differently. While they did exercise their fluid identities, I am concerned that it happened unconsciously, or at least without considering the ramifications, alternatives, and potential outcomes. I would argue female engineering co-op students need to become more aware of the choices they have and the factors in their decision-making. Fluid identities are most useful when they can be a

strategy, not a reaction. My concern lies in the women's response as automatic, having not considered their choices nor the implications of their response. This is where cooperative education must step in to ensure that the women understand there are choices in their communities of practice, and choosing not to shift their identity may be as acceptable as choosing to become one of the guys. Anna had always considered herself a tomboy, so this was not as challenging. There is not one correct answer, but it has to be right for the individual. The use of fluid identities is then positive, regardless of which identity, as long as the choices were consciously considered based on the options and implications. These women *should* exercise their fluid identities so as not to be limited by any gender binary. The women need not be bound by dichotomous limits when they imagine their place in a community. Thus, they should imagine what is possible without having to choose to be a feminine or masculine. Fluid identities provides a calculated response to a community where they may need to strategically align or disjoin themselves.

Recognizing the Role of Confidence in Identity

As I have shown thus far, gender and identity are key spaces within a co-op community of practice where the women were challenged. One additional factor that adds to the complexity of how gender, identity, and learning intersected was the women's sense of confidence. When speaking of themselves prior to the the co-op, the women described insecurities, their

lack of identity with their major, and overall doubt as to whether they could actually ever be an engineer. Before their co-op experience, they were unsure as to their ability to meet expectations and succeed in the workplace, but when speaking of outcomes and reflections on their accomplishments, all 11 of the women described their increased confidence and shifting identities from students towards that of engineers as a result of the co-op experience. All of the women went from some degree of self-doubt and limited confidence to an overall increase in their own confidence as engineers and an identity that had shifted or was in the process of shifting from engineering major to professional engineer.

I want to stop here before talking about these transformations and first explore the potential reasons for their lack of confidence. As students, their lack of experience in their field outside of the classroom (for those without previous co-op experience), in addition to the lack of knowledge in understanding the expectations for engineers in the workplace were the biggest factors in their self-doubt. Yet this still does not uncover the statistical significance between the overall and female cohorts' levels of confidence in the pre- and post-surveys. In the pre-survey, the female cohort's starting levels of confidence were consistently lower than the overall cohort's levels of confidence. The lower levels of confidence shown in the quantitative results of the pre-survey were also evident in the interviews, as I have

described. So then why did the overall cohort begin with a higher level of confidence?

I propose four reasons for the female cohort's and the female interviewee's lack of confidence before their co-op: the lack of other female role models, a lack of evidence that women could be successful in the workplace, gender stereotypes, and the women's own identities. The first reason for this lack of confidence is the mere lack of female engineering role models. From 11 women, only one spoke of an older sister who was a practicing professional engineer. Other than that, no woman ever spoke of a female friend, relative, or acquaintance who was working in the engineering field. This does not mean they do not know of any, but there was no evidence. In addition, the university enrollment statistics provide numerical evidence that there are fewer women. (3 men:1 woman - overall undergraduate enrollment; 22% women - enrollment in the College of Engineering) Thus, women are a minority in their classes, and when they arrived at the workplace, nine out of eleven women were either one of very few female engineers or the only female engineer. So regardless of the site, there were very few women around, and this provides very little evidence that women belong and even less evidence that women can be successful. In addition, some of the women cited gender stereotyping, even the message that women were not intelligent enough or capable of working as engineers. And lastly, the women did not

see themselves as engineers, nor were they certain this was their future identity. They had no evidence that they were actually capable to meet the workplace expectations, despite their success as engineering students. They could not identify as *engineers*, only engineering students. Remember how Emilia described herself when she first began. “Because you know, you come into college. Ooh yeah I'll do electrical engineering thing sounds kind of cool. But you don't actually know what it is.” She had declared her major, but having that marker did not make her identify any more as an electrical engineer.

Considering the possibility that a lack of evidence may affect the women's confidence, perhaps the ample evidence of successful men (National Science Foundation, 2015) could have also led to some men feeling overconfident. With the plethora of role models and the evidence that men can be successful, it may lead to an assumption that they too will be successful men, underestimating the expectations and challenges that can arise in the workplace. Confidence then may be complicated by assumptions of gender, because the gender binary only provides two choices, masculine or feminine. As I previously described, women see fewer women who have been successful, in comparison to men. Thus, there is the possibility that gender perceptions and the binary can affect confidence; meaning the

perception of gender prevented women from confidently identifying as an engineer prior to their co-op experience.

A PRODUCTIVE USE OF AMBIGUITY

In feminism's early arguments, there was a lot of emphasis on the binary of men versus women. "The bond that unites her to her oppressors is not comparable to any other. The division of the sexes is a biological fact, not an event in human history...Here is to be found the basic trait of woman: she is the Other in a totality of which the two components are necessary to one another" (de Beauvoir, 1994, p. 10). We need to think in more complicated ways, not at what it means to be or act male or female, but rather how can we move beyond biological facts and into a space that rejects this boundary and the option of only two. More recent feminists (Haraway / Harding) have criticized this binary, arguing that we are focusing too heavily on men versus women. If those limits were lifted, what could the women imagine for themselves and how might their confidence change? Before moving into a final discussion on the model, I will first explore how productive ambiguity may be useful in resisting the binaries and finding a more productive space from which to work.

For this discussion, I am using the term ambiguity to mean indefinite, undefined, and most important when considering ambiguity in a work setting, equivocal and the possibility of multiple interpretations. Ambiguity means

vague and the lack of definition allows fluidity, similar to fluid identities.

Ambiguity means there may not be one answer, one label, or the need to define. For the women, ambiguity complicated their work and their identities.

This type of ambiguity in the workplace was best defined by one woman's description of work versus school. She described academics to be the search for one true answer, a mystery; ultimately, it was held by the professor. The goal of academic work was to discover *the* truth. In industry, however, there is never one answer or only one option. When a project is assigned, there are many variables, and each of those variables provides viable options. In work, the goal is not to discover one truth, but to identify the options and make a decision, accepting the ambiguity that there is no one right answer they have to find. For some women, it was difficult to make this shift and have the confidence to trust themselves and the choices they made. Yet, they quickly learned that their own confidence and identities as engineers partially rested on how they portrayed themselves to others regardless of the ambiguity, because portraying confidence was key to maintaining respect.

Anna recognized this in her work, and remained conscious of her language and actions in all of her decisions. "So when it came to decisions that I had to make, the biggest thing for me was that I needed to stand my ground for my decision, because if I hesitated at all, then he would throw it back in my face and think that he knew better." If they were ever unsure, their credibility amongst co-workers could be compromised. So despite the ambiguity, they

had to remain confident in every decision they made and their fluid identity had to present evidence of self-confidence, whether they believed it themselves or not.

Another productive use of ambiguity came with the women's gender and identities. This gender ambiguity is very different than the binary of female versus male that some women negotiated in the masculine communities I have previously described. Much different than needing to be one of the guys, there were communities that did not require one to choose gender. Part of Emilia's mentor's success was his conscious effort to not let gender affect his work. She described her mentor's approach to his mentees, focusing heavily on their role within their company, rather than the label of their gender. "I want to teach you all you need to be a good engineer, whether you are male or female. I don't care what you are. He was very supportive in those ways." Here the mentor was not focused on gender, what that gender may mean, nor the expectations associated with gender, but rather he focused on the engineer and what that individual was capable of without the restrictions of labels and definitives. There were some communities that looked past gender, so there were not male engineers versus female engineers, but rather engineers. Within gender then is an opportunity for ambiguity which leads me to the most useful space within the community of practice model I have proposed. Within the community of

practice and the spaces of negotiation lies an inner circle that provides an alternative to choosing sides nor leaving the community. I define this space as *The Cyborg Engineer*.

Working within the Community as a *Cyborg Engineer*

As represented in Figure 5.1, I identified gender, identity, and learning to be three key areas the women had to negotiate, ultimately affecting their experience and outcomes. Considering the binaries within each of those areas, the women experienced struggles and challenges when faced with male versus female, student versus professional, and the skills and knowledge they gained. Within these areas, however, lies an alternative space from which to work that does not require choosing sides nor labels; this is the space of the *Cyborg Engineer*, based on Haraway's cyborg metaphor. Haraway's (1991) *Cyborg Manifesto* provides a feminist approach that moves beyond the male versus female altogether. She rejects the rigid boundaries that we have created and rely too fully on, actually critiquing traditional feminism that leans too heavily on gender binaries and *Women*. Rather, Haraway argues that by erasing boundaries, there is more we can do together. "But a slightly perverse shift of perspective might better enable us to contest for meanings, as well as for other forms of power and pleasure in technologically mediated societies" (p. 154). This shift away from gender as the absolute determinate opens up the possibilities and the identities can remain fluid and undefined. When Haraway described facets of the cyborg,

there were two particular descriptions that are transferable to a co-op context and understanding the construction of the cyborg engineer. These describe both how the cyborg is created and where they populate. The cyborg is a “creature of social reality as well as a creature of fiction” (p. 149). And when she looks to contemporary science fiction’s use of the cyborg, it is full of “creatures simultaneously animal and machine, who populate worlds ambiguously natural and crafted” (p. 149). These two brief descriptions of cyborg are useful to this argument. First, because it arises from social reality there are ties to reality, rather than a completely fantastic creation, but that reality does not prevent possibilities because there is a fictional element also attached, allowing creativity and possibilities to inflict. This ensures the cyborg is based in reality, while not being restricted by that reality. In addition, this creature has an ambiguous nature, with natural elements coinciding with those parts which were crafted. Here then the cyborg has been crafted from reality and the situations from which it emerges, but without the dualisms and the labels, it may move beyond the limitations to remain ambiguous and craft the world in which it inhabits. Enter here the cyborg engineer, where it is not one’s femininity nor masculinity that defines it, nor does their gender provide power or limitations, and whether student nor professional is a non-issue; rather we can move beyond us versus them and instead focus on the more critical components of an engineer prepared to productively contribute to its community of practice.

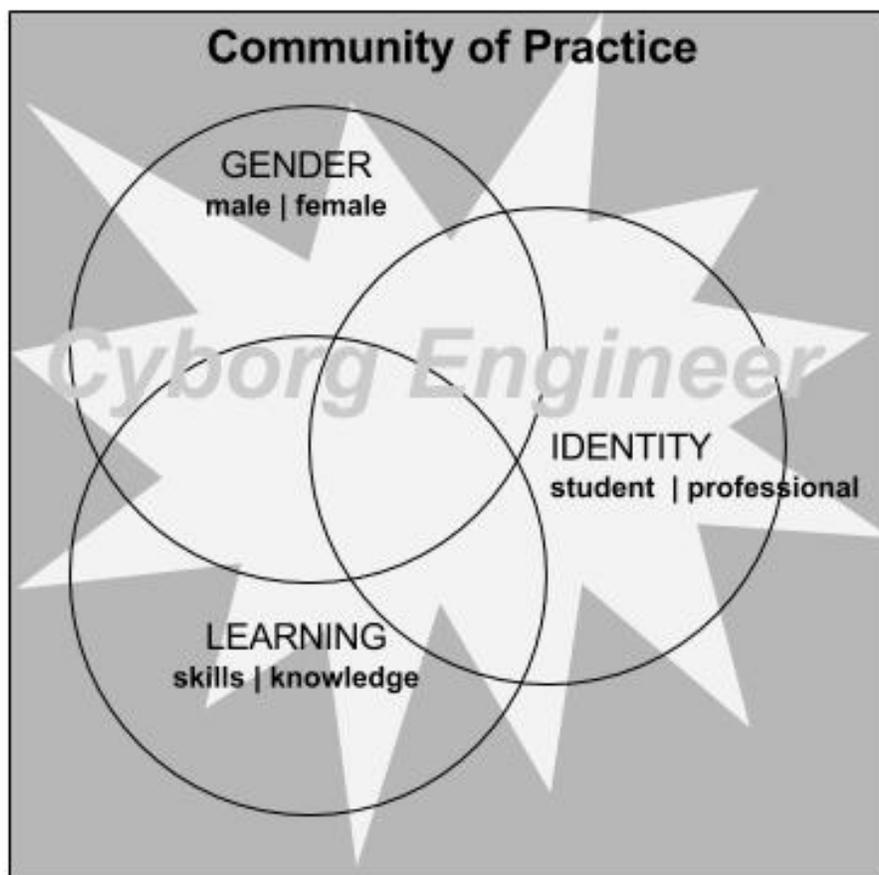


Figure 5.2 Locating the Cyborg Engineer within a Community of Practice

The cyborg engineer lies within the center of the binaries while still maintaining a space within the community of practice. In the community of practice, there are three areas the women negotiated - gender, identity, and

learning - and the women spoke of the challenges and negotiations necessary to operate within each sphere. The location of the cyborg engineer is effective because it lies within the community of practice, and though it is not free from the complications of gender, identity, and learning, within all of them is this space that provides a strategic location, relieving the need to choose a side, rely on any label, nor accept restrictions.

Cyborg imagery can suggest a way out of the maze of dualisms in which we have explained our bodies and our tools to ourselves. This is a dream not of a common language, but of a powerful infidel heteroglossia....It means both building and destroying machines, identities, categories, relationships, space stories (Haraway, p. 181).

The cyborg engineer stops looking at the boundaries and instead to the possibilities beyond them. Dualisms produce competition, which is not a solution to the problems, but rather a perpetuator of what prevents us to move forward. For example, the women began their co-op experience very much feeling like a student, doubting their ability to become a professional. They also questioned their skills and knowledge, wondering their own value in a co-op setting. These binaries became more significant for some and ambiguous for others once they entered their communities of practice. Those who were successful did not choose a side within those binaries, but remained fluid, shifting between without committing to either binary, and not allowing either to limit their success. They were operating within the space of

the cyborg engineer which allows their fluid identities to morph and change and remain in motion.

The cyborg engineer is carefully coached and crafted to more effectively navigate a community of practice. Most important is the critical lens that the cyborg enters with in order to know how to look for the systems at play, find a perspective from which to view the systems in order to make strange what others see as normal, and recognize the explicit and implicit, the represented and assumed, and the said and unsaid. She must ask questions. The viewpoint from which the cyborg gazes is most critical because she must be well aware of the community in which she is a part in order to craft herself based on both the realities and the possibilities. She must not allow the gender and identity perceptions and norms to limit those possibilities, nor can she refuse to be silenced by the community because of any labels or binaries in operation. She needs to use her voice, on her terms. Within the community, the critical lens should provide her the choices that are available, and the recognition that she is not forced to choose because it has always been. In making a choice, she should consider the implications for herself and others, but ultimately make the choice she sees as the most propitious. By recognizing and understanding those systems at play, the cyborg engineer can better craft her actions and responses, ultimately working to cause shifts in those systems to better serve those outside the majority. This

then opens up the community to welcome others, and the cyborg engineer recognizes her role in shaping the community and even larger, the communities of future female engineers. These crafted responses and disruption to systems may be considered a type of metis, thus metis offers the mindset and action of the cyborg engineer.

Using Metis as a Constructive Mindset

The concept of metis provides a mindset and a response for the cyborg engineer which would give agency to those whose bodies are typically lacking in power and strength, because of their awareness of the community's practices, the carefully considered choices within the community, and the power gained in producing a crafted response. Originating in the Greek myths, Metis was a goddess who was "equipped with an attunement to contingencies, an inherent preparation for unexpected situations," but accompanied by that was the ability to shapeshift (Hawhee, 2004, p.49). Ultimately, she was consumed by Zeus, who embodying Metis, then went on to be more powerful than all. Metis is a resourcefulness of the mind and body, prepared for any situation, superior when put on the spot. In the Greek Myths, it made up for a physical weakness, providing a more level playing field, or an opportunity for what may be perceived as the weaker to finish as victor. In many of the stories, those with metis were actually considered the weaker party (due to gender, disability, etc.), but they were victorious despite their weakness. Metis provides strength, but the strength

may be invisible based on physical representation. Thus, mind and body cannot be separated as metis is holistic. While the mind may play the most significant role, metis returns to the body. Based on Greek Mythology, some terms that describe metis are deception, resourceful, and trickery. The last term brings a negative connotation to metis, thus metis is complicated because of the ethics involved when one crafts strategically. I would argue that adopting it with a careful eye on the consequences provides a valuable method to critically analyze the norms in a community of practice. Ultimately, this is a valuable method for questioning and thinking through that which is strange.

Brady (2003) studied two female professional communicators and how they “used the discursive technology of rhetorical problem solving...to find places for themselves where they could do their work” (p. 222). Billie, one of these women, though hired as a professional communicator, was considered more of a secretary by those she worked with. In her role, Billie crafted two methods for communicating with authors which provided her ways to gain what she needed. One was to “play totally stupid,” while the other was to construct her speech differently depending on the author. These were choices that Billie made about how she would present herself. “Billie constructed her false identities, which she used to overcome resistance to her editorial authority” (p. 225). “She devised a strategy that enabled her

to prevail in adversity without exceptional strength” (p. 226). Billie did not name her strategy as metis, but Brady makes the connection to this specific rhetorical strategy that allows Billie to get what she needs despite the circumstances. Metis, according to Brady then, includes “flexibility and resourcefulness, characteristics that predispose them to use what is available to them, in whatever adverse circumstances they find themselves, and often to prevail, even though they do not possess exceptional strength” (p. 221). Understanding metis and how it can be used is empowering, but its unpredictable nature also means a balance of power and deceit. “*Metis* is thus the mode of negotiating agonistic forces...The force of metis distinguishes action that would otherwise be predictable” (Hawhee, 2004, p. 47). Thus, we cannot talk of metis without also acknowledging its ethical implications, both for those who are on the receiving end, as well as the women themselves. On the one hand, metis levels the playing field and provides access and strength where it is not otherwise attainable. But is it ethical to deceit and trick? This is a question that brings up many layers, because we could also ask if it is ethical that these women are in these positions in the first place? Was it okay for Billie to be treated as she was when she was just trying to do her job? Is it ethical that some women have to be one of the guys in order to gain respect in their community of practice? And what if the outcome of a metistic strategy is one that benefits the greater whole, an outcome bigger than the individual?

There is not one answer to the question of ethics, but there is a key step that must not be missed when we offer metis as a method for questioning, critical analysis, and a response - the cyborg engineer must identify potential outcomes and implications of each choice one considers. When metis is the response, there should be some consideration of the ethics involved and the implications of each action. For example, the women's fluid identities were a form of metis, specifically those who crafted their identities to be seen as more masculine, thus shifting aspects of themselves to align with the community. Did the woman who spoke "with a sailor's mouth" trick the men into thinking she was more like them? Was she comfortable with herself when she participated or was she using language for acceptance, neglecting her own values? When one feels they are required to participate in certain practices, even if they do not agree, might they then feel suppressed, silenced or marginalized? This may not help to change anything in the community nor for future women. Alignment, when one really does not want to align, means leaving the status quo unquestioned and passing on an opportunity to disrupt the practice. Not only may that be detrimental to their own sense of self, but damaging to women who come afterwards and want to make an alternative choice. The ethics in metis then are as crucial for the individual as they are for the community. The cyborg engineer then must possess an astute awareness so they are cognizant of the choices and

believe they can choose despite community expectations. With awareness comes an eye for opportunities, which are then new possibilities. “*Metis* provides a model for the ways we might repurpose rhetorical tensions around bodily values, recognizing the stigmatization and effacement of bodily difference, yet also mobilizing new stories and new expressive possibilities” (Dolmage, 2009, p. 8). As was the case for the women Brady (2003) described, there were clear methods for controlling a situation or making a strategic choice, rather than silently and powerlessly accepting it. *Metis* then provides the ultimate tool for ensuring one recognizes options beyond just accepting the norm, while also identifying the implications associated with their choices.

When preparing women for their co-op experiences, there are of four key steps, which ultimately provide the insight and practice of *metis* to more actively respond, rather than passively accept. The first step is to gain knowledge, so for these women they would need knowledge of other women’s experiences in a community of practice similar to where they see themselves. The timing of this could begin prior to the co-op departure, but continue throughout the co-op experience. This knowledge could come in the form of readings, but also more personal connections with women through alumni and other professional networks. Personal interviews are also an effective way to gain information, and these conversations can lead to

unexpected outcomes. With some prior knowledge, when the women enter their worksites they will then have something to compare or at least information regarding the norms, a perspective from which to gauge their own experiences. Once working, the next step is discussion, which could be with other students, a campus representative, or someone at their own worksite. The key is to get them talking about what they are seeing and experiencing, while trying to make sense as to what that means. What types of practices do they question? Where do they see something strange? What do they like? They need an opportunity for discussion to uncover and question that which may be strange to them. Overall, it is important to make them aware, get them thinking about their own experiences, and ensure they will not be left to the fate of their circumstances, rather they will have some knowledge and insight to better handle a new community. Ultimately, the hope would be that they would not work as passive observers, but with more experience, they see themselves as agents of change. In the fourth and final step, they are encouraged to recognize opportunity. This step needs to be clarified with the caveat that recognizing does not mean acting. In a co-op situation, these women may not have the voice nor the confidence to step up or share their ideas, because they are only a temporary employee with student status. We cannot expect them to make change in just a semester or two, but if we have given them this model, the goal is that they take this into their future full time positions and enter them better equipped for

opportunities when they arise. They need to be astutely aware, because this provides them more opportunity in their imagination to identify possibilities for themselves. Only then can they respond with a method of which they choose, gain some control, disrupt that which is normal, and make a difference for themselves and others. When women enter new communities, it is important that they recognize the methods available for gaining information key to making decisions and recognizing different choices they have in accepting and rejecting the practices of their community.

The success of the women here provide hope for the cyborg engineer, as was evident in the stories like Lida's inspiring mentor who encouraged her to return to campus as a leader, or Anna's rejection of the barriers for women in test and development, ultimately making an opening for women in the future. Or Veera, being the only woman who earned the respect of her colleagues when she proved to them she was capable of making valuable contributions to the project team. These women did not rely solely on their gender, nor did they allow their student status nor their early lack of confidence to limit them. More importantly, they learned skills and gained knowledge to *do the work* of an engineer but also utilize the knowledge gained to effectively negotiate their alignment within their communities to find their own place, effectively altering their identities. These stories offer examples of what other co-ops can now imagine for themselves because it was possible for these women.

By providing strategies for female engineers in a co-op experience, we can assist them in negotiating their communities of practice, ultimately operating as Cyborg Engineers, preparing themselves to continue to pave the way for others.

CONSIDERING COOPERATIVE EDUCATION AS A LOCATION FOR STARTING SOCIAL CHANGE

As we turn back to the practitioner's role in cooperative education, we should consider both the possibilities and the limits that we have within the co-op curriculum to better serve our female engineers. As part of my teaching philosophy, I believe all educators should have some responsibility in ensuring they are contributing towards leading our students to be positive humans in a world that is in desperate need of individuals making a difference in their own little corner of the world. The opportunities that we have in our day to day lives to make a social impact is largely underestimated, yet this is a place we have direct access. A co-op experience may be one of the student's first significant introductions to the real world and our opportunity to ensure this introduction allows them to see their potential for participating in their communities of practice. Students may easily overlook their potential impact and the significance of even small actions.

This is where we can take cooperative education as we prepare women to leave their universities and enter their work sites. Using the cyborg engineer model, there are key components that provide strategies for the student to best operate within a community of practice in which she is a minority: methods to ensure she has a perspective that recognizes the larger system, her role in that system, and opportunities to take action when it is not working for herself and others. There needs to be an awareness of action and opportunities for social change, change to affect both the present and the future. This then brings up whether cooperative education is best served by critical pedagogy in creating students who operate as cyborg engineers, refusing to accept the status quo without careful consideration.

Nancy Johnston (2008) raises the question as to whether critical pedagogy is appropriate for a cooperative education curriculum. Ultimately, she does leave it up to the curriculum developers, but at the very least, she urges us to consider our role - "whether there is a responsibility to help students learn how to critique and transform those workplaces for the better. It questions the social responsibility mandate of cooperative education and in so doing challenges some of the very foundations and partnerships upon which co-op rests" (p. 23). To better understand this critique and transformation, Johnston identifies the issues being power and domination, with calls for fairness, equity, and social democracy. When Johnston identifies fairness, equity, and

social democracy, there is a direct alignment with the awareness of the cyborg engineer, so a critical pedagogy is one that includes components to teach students how to approach a new community with a critical lens, with the goal of changing communities to be more inclusive, ultimately creating a place of equality. “Critical theorists seek to expose and change hidden educational and workplace processes that privilege those already privileged” (p. 23). Here again is a similarity in the focus on the hidden processes that reward those already privileged. Considering the call for action I have made, I would argue that critical pedagogy is an appropriate response because the goal for our students is not to assume they must act as passive observers, but ultimately leaders in their workplaces who can recognize practices and policies that do work for all and find ways for change. With critical pedagogy, we can introduce these concepts and the key components to help students understand their various roles in the workplace and the choices they will have. Zegwaard (2015) makes this exact claim as he calls for agents of change.

That is, graduates that understand what it means to be a professional in a professional context rather than just being able to engage in a set of tasks and interactions in a professional context. Such graduates would be enabled to cause change around them for the betterment of the workplace and its practice, which means these graduates would be agents of change rather than participants of the norm (p. 94).

Campbell and Zegwaard (2011) ask a similar question: should professional ethics be a key component to cooperative education? Their vision of professional ethics sees the student as a *critical moral agent*: “actively making choices whilst critically evaluating their moral implications” (p. 210). Their version of the critical moral agent is an empowered self who is an active participant aware of the ethics at play and prepared to identify potential change rather than passively accepting unethical community practices, even when others accept it. “A sound professional ethics education will enable the individual to be critically aware and analyze practices around them rather than merely being socialized and enculturated into existing practices and values” (p. 205). This socialization and enculturation is what Wenger warned of during alignment. All three of these terms, though slightly different, all point in the same direction as the call for action I have identified in the cyborg engineer model, thus these are options for how a co-op practitioner can devise a curriculum with a goal of the keen awareness and strategic action of the cyborg engineer.

Returning to the women in this study, the social change component of the co-op curriculum is especially important for women in engineering, because it is crucial that we address how they can identify the practices within their communities, but then critically assess questionable issues they see to be problematic. Within these communities, they are not to serve as passive

recipients, but they should critically analyze these communities, identify the choices they have within them, and recognize where there are opportunities for change or action. While the circumstances may not allow them to take action as students, this sense of awareness will only allow them to be better prepared as future professionals where they will very much have the opportunity to create change and make a difference to the communities they will be a part of. When new to a community of practice, it is impossible to become a full member without understanding all of the complexities. This prevents some co-op students from gaining full status, merely because of the lack of time. But this experience as a newcomer is valuable nonetheless. In their future communities, they will again be newcomers, but potentially only temporarily. Their full membership will come with the additional responsibility of contributing to their community to make it a more just community for everyone. Lave and Wenger (1991) spent some time on this challenge of moving from newcomer to full member. "Newcomers are in a difficult position because at once they have to engage and understand the existing practices which have developed over time and eventually become full members, but they also have to make a stake in the community and its development in order to "establish their own identity in its future" (p. 115). As members of their future communities of practices as professional engineers, they will have an opportunity to either allow the community to continue as is or take a role in making a difference. A community of practice is never static, rather it

is always changing based on the individuals who make up the community. As members, they can either silently disagree, disagree and choose not to participate, or they can speak up, propose a change, and be a part of changing that community of practice to better serve members, but also the non-members who may be lurking on the outside because they do not see a place for themselves. They can do the work to make their communities more inclusive for a more diverse workplace.

FUTURE WORK

Throughout this entire study, there have been opportunities for so much more than I am able to capture here. When I began, I truly did not know where the data would lead, or as any researcher fears, if there would be anything even worthy of discussion. As I quickly found, there was enough and more that came from the quantitative and qualitative data that I collected, and there is so much more I can still do with what I gained. But even beyond that data I have here, there are also further studies that would provide additional data to richen what I have already found. For this, I propose three potential areas to continue this study that would provide key research into women, minorities, and co-op, including data that would provide insights into the long-term outcomes of these experiences.

To continue what I have begun, I would propose following the five women who participated in the interviews so as to see what is next. One of the

women graduated in December 2016, while the others are continuing their degrees. I would be most interested in their post co-op university experiences, their job searches, and then follow them into their first year in a full time position. Learning more than what I was able to capture from just one semester would provide a more holistic assessment as to the more long-term outcomes of a co-op.

Another related study would be to gain access to current female engineers in industry with university co-op experience who have been working as professionals for 10-plus years. In the current study, I did not have the perspective of current professionals. Thus, I would want to interview female engineers from a variety of industries to learn more about their experiences and key moments of their career, the challenges and successes they have experienced within their communities of practice, and a discussion on the co-op experience and how it helped, or not, as full time employees. Again, this provides longitudinal data focused on the outcomes of cooperative education, while maintaining a focus on the experience of female engineers. The combination of students and experienced professionals provides a well-balanced pool of research in from which to view the experiences of these women, but then to assess how the new data affects what we are able to do currently with cooperative education curriculum and our role in the initiatives of recruiting and retaining females in the profession.

While there are other studies on the long-term impact of the co-op experience, this has not been done with female engineers. Considering that the retention of women is as important as the recruitment, a study that follows women for longer than only a semester would be a valuable contribution to other co-op practitioners because while it is important to focus on the present, a more holistic look at how the experience may affect female engineers in the long term would provide key data to make decisions utilizing a perspective that is knowledgeable beyond the present needs of our students. Without knowing the long-term, it is difficult to prepare our students for their later careers. And while the students may have very clear goals and directions now, this is no guarantee of their future realities. Equally important to providing current co-op women a voice and opportunity to share the realities of their co-op is the opportunity for current professionals to share their stories. Those who could benefit from gaining these insights are not only co-op practitioners but other women, the academic departments, and even those committed to increasing the number of female engineers.

Finally, another population of students who require a more careful look at their co-op experience are the international students who participate in cooperative education at Michigan Tech. This group is typically graduate-level MS and PhD students who leave campus to work as a co-op or intern

for one to three semesters. For this population, there are numerous cultural implications, from their status in their home countries and how that is affected by co-op, to the cultural differences they encounter when working in a U.S. company for the first time. The reason I would want to conduct this study is to prepare a cooperative education curriculum that is better suited to their very unique needs. Currently, the curriculum is nearly similar for the undergraduate and graduate students, but I do not believe it is serving both populations as effectively as it should. Rather, the international students are in a very different place, meaning they are studying and working in the United States with a lot more at stake, whether that be family, their future abilities for sponsorship to remain working in the U.S., or even their obligations with their home countries. Thus, there is a need to better understand the population and their objectives for cooperative education, plus the unmet needs that remain when they both begin and end their co-op experiences. This study would provide other universities a model to examine the students participating in their cooperative education programs in order to determine specific populations with unmet needs. While they may not have international students, it could be minority students, first-generation college students, or even students with disabilities. Regardless, the overall goal in this type of research is to critically examine the program participants to determine who may not be best served and then identifying their needs. From here, programs can then revise their programs to more inclusively serve all

students in assisting them in their co-op experience and ensuring their learning within a community of practice results in a positive transformation in their identities.

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